



U.S. DEPARTMENT OF AGRICULTURE
BUREAU OF PUBLIC ROADS

Public Roads

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WASHINGTON, D. C.

DECEMBER, 1918



ON PHANTOM CANYON HIGHWAY, COLORADO

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The Bureau of Public Roads and the Government Printing Office desire to issue **PUBLIC ROADS** regularly each month, but long delays often are unavoidable, as in the case of this, which, while preserving its regular number, 6, is issued as of December, and necessarily will make Vol. I consist of ten numbers instead of twelve. The delay, however, has afforded the opportunity of incorporating late matter, notably that touching the death of Logan Waller Page.

U. S. DEPARTMENT OF AGRICULTURE

BUREAU OF PUBLIC ROADS

PUBLIC ROADS

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WASHINGTON
GOVERNMENT PRINTING OFFICE
1919

BUREAU OF PUBLIC ROADS

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P. St. J. Wilson . . . Chief Engineer

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TRIBUTE TO LOGAN WALLER PAGE.

Delivered by A. D. WILLIAMS at Chicago, Dec. 11, 1918.

WITH sad hearts the Nation bows with us to-day beside the body of one of her noted men, Logan Waller Page, our companion and friend, who by word and deed gave his time, energy and strength, his "all" we might say, as a pioneer of road building in America.

When most of us gathered here scoffed and doubted, Logan Waller Page utilized his daylight hour and burned the midnight oil, studying the problem of our highways. His works have helped to make possible our presence to-day.

His position was not one of large remuneration, but one of vicissitudes and worry. The past years' burdens have borne heavy upon him. His struggles with bureaus and committees, coupled with the anxiety he felt for what might be done here took their toll. Conversations with him just before his death revealed his deep interest in the question near his heart. His efforts were guided by unselfish motives. He, in common with honest men, was sometimes misunderstood, misquoted, and misjudged by those who would further selfish interests.

The pioneer in the field of science is not guided by visions of material gain. It is not the thought of pecuniary returns that impels him to spend his hours, days, weeks, and years seeking hidden truths whose revelation is to find appreciation only in the passage of time. Back of the action, back of the man, there is an unselfish and divine impulse of the soul that compels him to contribute of his life that part which makes other lives brighter and the world better, that part which will help to lift the load from his fellow man. Logan Waller Page has contributed much to smooth the ways of travel, to turn aside the stones over which we stumble, to widen the avenues along which we must work, and has made safer, brighter and lighter the Nation's pathways for the feet of commerce, liberty and happiness. He had his faults as all men have; he would not have been human nor would he have been a man without them. With some of his views many did not agree, but regardless of personal opinion, every man who came into contact with him was compelled to recognize that there was a sincerity and fixedness of purpose backed up by a spirit of fairness.

It is said that when Napoleon, at the close of his career, was asked what he considered the greatest and most beneficial act of his life, after a pause, stated, "The system of roads I have given France will be the most beneficial to her." It took almost

a century of time and the recurrence of a war to corroborate that statement; but there is none of us to-day who will not agree that the roads of France saved her and civilization.

The highways of America, though incomplete and inefficient, as they have been in the present crisis, nevertheless contributed to win the war and save democracy, and when we stop to think that few men in America have done as much, have contributed as loyally, as faithfully, as persistently and as conscientiously for the improvement of our highways as Logan Waller Page, we can not but feel that America has lost one of her worthy men; one who strove sincerely to foster within the Nation a desire and an appreciation for a system of transportation that would reach every hamlet and establish firmly and forever civilization in every section.

Those of us who were permitted to live near Mr. Page and came in contact with him learned to love him. Those of us who have fought with and against him, have agreed and disagreed with him, learned to appreciate him because of the honesty of purpose with which he strove. As an earnest friend of better government he worked continually and effectively for efficiency in administration of public affairs. He believed that the road problem could be solved only through scientific research, observation, constant and honest administration. He sought and recommended the employment of trained men, so that the improvements made on our highways would be as permanent as possible; but at the same time he sought to foster the cooperation and friendship of the man who lived by the side of the road. He sought at all times to get the highest efficiency at a minimum cost. He was diligent and faithful to his task.

It was his oft expressed wish that when the end came it would find him in the midst of his work. His wish has been granted. If his silent lips could speak and we were asked what should be done to commemorate him I know that he would say to each and every one of us, "Do your best honestly, faithfully, sincerely and economically to remove from the pathways of the Nation the barriers and burdens that bear it down and make the citizens of many sections slaves of mud and neglect."

Nothing, my friends, that we could say here would add anything to or detract from Logan Waller Page or his life. His story is written, his life speaks, his works live and will live long after we have passed from this hall.

Logan Waller Page

1870—1918



A
Tribute
to
Logan Waller Page

Logan Waller Page, Director of the Federal Bureau of Public Roads, whose sudden death occurred at the Hotel La Salle, Chicago, ten P. M. December Ninth, Nineteen Hundred Eighteen, while attending the annual meeting of the American Association of State Highway Officials, of which he was an active member, was and can be classed the Nation's real pioneer in scientific highway construction. By word, pen, act and deed from his early boyhood to his untimely removal he has contributed unceasingly his entire strength, energies and time towards the establishment of better methods and more scientific statutes for all of the states and the nation.

He more than any other one man, has stood always for scientific road construction, for education and the use of educated and experienced engineers in carrying out road work.

He was inevitably, firmly and unalterably opposed to political appointments and to any interference or influence by outside interested parties.

By the death of Logan Waller Page, this association and the road builders of the whole United States have lost one of its members who cannot be replaced.

A cultured gentleman, scientist, experienced counsellor, faithful and lovable friend; we desire to join with his family and his multitude of friends in mourning his loss.

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HOW COUNTRY MET MAINTENANCE PROBLEMS OF THE PAST YEAR.

MAINTENANCE of thousands of miles of roads so that the enormous Government and commercial truck traffic of the past 15 months could move has taxed the abilities and called forth every energy and possible plan on the part of the highway officials of the country. To the road destruction which naturally followed the increase of traffic, and a traffic for which the roads were not originally constructed, was added during last winter the difficulties of almost unprecedented snow blockades. In many States officials found themselves without sufficient funds to properly handle the repair and rebuilding work necessary. Nearly all of them had to struggle under the handicap of an insufficient labor supply and all had to meet the increased cost of labor and materials. Only a few States were unaffected by the restrictions on the supply and transportation of materials which had to be brought from a distance.

None escaped the difficulties which followed the great and rapid increase of traffic which so suddenly followed our entrance into the war. From New England to the Pacific coast new demands were made upon the highways and unusual conditions developed everywhere in maintenance and construction.

Highway officials some time ago were requested to write for Public Roads of the maintenance problems which had developed in their respective States and of the way in which they had been solved. The articles received tell interesting stories of the difficulties which had to be overcome in order to keep roads open for traffic, and contain much that will be of great value in planning for future construction and maintenance.

TRAFFIC AND STORM DESTRUCTION.

The States in which the heaviest traffic centered are those north of the Ohio and Potomac Rivers

and from the Mississippi to the New England coast. In these States there has been a constant procession of heavily loaded truck trains, and the breaking down of even the best type of roads has been frequent. It is worthy of note, however, that before the end of the summer most of the difficulties arising from this condition had been fairly well met. In Colorado and other States in the West there was not only a largely increased automobile and truck traffic, but roads were destroyed by unusual storms, making both a maintenance and construction problem to be carried on under adverse conditions.

In Pennsylvania, New York, Ohio, Michigan and other States it was necessary all last winter to fight the snow blockades. Officials tell how roads were kept open. For the coming winter plans have been made for keeping the roads clear of snow by the purchase of plows and other equipment, through better local organization and in other ways. In some cases special funds have been provided.

PATROL SYSTEM IS NECESSARY.

In several States high type roads which had originally been constructed without sufficient foundation to meet the new demands had to be rebuilt, and part of this construction work was carried on while the heavy traffic was kept moving. Nearly all the articles show the increased dependence upon local material for repair work and for new construction. Costs of construction advanced to such high figures that appropriations proved too small and work that was done was to solve immediate problems, and that of a more permanent nature left for the future.

Several writers emphasize the importance of the patrol system. There is very general agreement that such a system is absolutely necessary to efficient and economical maintenance.

Wisconsin's System of Road Maintenance Has Given Good Results.

By JOHN A. HAZELWOOD, Chairman Wisconsin Highway Commission.

THE Wisconsin Highway Commission on May 1, 1918, under the State highway act passed by the legislature in 1917, took over the maintenance of a 5,000-mile State trunk highway system. The act referred to not only required the Wisconsin Highway Commission to assume the responsibility of

maintenance of the State trunk highway system but liberally provided money for the highway work.

The automobile license fees in Wisconsin were doubled, and from them a fund of over \$1,000,000 was created for the purpose of maintaining the system.



GIRLS DRAFTED FOR ROAD WORK IN WISCONSIN.

TYPES OF THE STATE'S HIGHWAYS.

When the State assumed the maintenance of the 5,000-mile system there were approximately 100 miles of concrete surface, 600 miles of stone macadam surface, 1,200 miles of gravel surface, 200 miles of shale, and 3,400 miles of earth road.

The condition of the concrete road at that date would be classed as good. The only maintenance required was taking care of the joints and cracks and some shoulder and ditch work.

The condition of the stone macadam varied to a great extent. Probably 400 miles had been surface treated. Some of it was in good condition, but a large percentage of it was either in a fair or poor condition, and the balance had never been surface treated, and in many instances was in fully as good a condition as some of the surface treated portions that had not been properly maintained.

Of the gravel and shale, probably 50 per cent had been constructed under our State aid law and was in reasonably good condition in so far as shoulders and uniformity of surface was considered, although in many instances it required new material as the surface was becoming worn. The other 50 per cent was ordinary town gravel roads. Material had been dumped in loads very unevenly; the grade in many instances was narrow and very poor drainage had been provided.

Probably 25 per cent of the 3,400 miles of earth road had been previously built with State aid or

county funds and was in reasonably good condition to be maintained. The balance was ordinary town roads on which no great amount of work had ever been done, and in many instances little drainage whatever had been provided.

PATROL SYSTEM AND MILE POSTS.

The commission determined at the outset that the only method for the proper maintenance of so large a system of roads, including probably 3,000 miles that had never received any intelligent maintenance, was by a patrol system.

The act creating the State trunk highway system also provided for a systematic marking. The Wisconsin marking system is probably the most thorough and complete system anywhere to be found. Direction signs are used so that it is impossible for travelers to lose their way who tour the State from east to west and from north to south without making inquiries as to which road to travel. The system also includes mile posts, 5,000 of them used on the system, upon which are indicated the number of miles, west from the eastern part of the State on roads running east, and the number of miles north from the southern part of the State on roads running north and south. The marking system at intersections also includes a complete lot of signs giving distance and directions to villages and cities. Danger signs are put upon the system at all sharp curves, railroad crossings, and other dangerous places.

Under our State trunk highway law the counties must maintain the system under the supervision, direction, and advice of the highway commission. The trunk highway system passes through each county seat and all cities of 5,000 or more inhabitants. Therefore, a portion of the system lies within each county of the State and the portion so lying in each county has been divided into patrol sections of from 6 to 10 miles each. Patrol sections vary in length according to traffic conditions, type of road, and location of patrolman employed.

DIVISION OF THE FUNDS.

A sum of money from the automobile fund has been set aside for each section sufficient to provide the salary of patrolman and any assistants on patrol maintenance that he might necessarily require. The balance of the maintenance funds available from the automobile license fees in each county was distributed over sections requiring special work such as heavy blade grader, scarifying stone or gravel surfaces, surface treatment, and surfacing old macadam or gravel roads.

The patrolmen are hired for the season on a monthly basis at an average salary of \$130 per month for man and team, the county furnishing the necessary tools. The patrolman gives his whole time to the work during the season for which he is employed. He is required to be on the job from 7 in the morning until 6 at night with one hour off for luncheon. On earth road sections as soon as the surface is dry enough after each rain the patrolman makes one round trip over his section with a light grader. He drives nearly in the center of the road, generally throwing material from the center out. The idea is to immediately fill ruts caused by traffic. After this first trip with a light grader, the road planer is used to smooth up the surface. The Wisconsin Highway Commission does not believe in high crown roads even on heavy clay soil. We obtain good deep ditches where possible, our maintenance cross-section providing for 24-foot width from shoulder to shoulder with a crown not to exceed 8 inches.

HEAVY BLADE GRADER WORK.

Any portion of a section deemed impossible to maintain in its present condition has been ordered graded by a small gang consisting of tractor engine operator, grader operator and about two men and teams with fresnos or slip scrapers. We have completed to date about 300 miles of this heavy blade grader work. Results have been very satisfactory and the highways have been easily maintained. A 40 horsepower tractor and a 10 or 12-foot grader is used for the grading operations and all surplus material in cuts and on high places is

slipped ahead by the teams to some low point. By this method the grade is widened out to 24 feet except only in cuts or on high narrow fills and in the latter case, a guard fence is placed on the fill for protection to travelers.

The gravel roads have been maintained by the adding of new material where needed on those built by state or county aid. On those portions that have been built by the towns in previous years it has been found necessary in the majority of cases to scarify the surface to the full depth of material placed, thereby making it possible to even up the surface with a road grader so that when rolled down again the wavy appearance will be entirely removed. Scarifying in this way also permits the removal of any coarse stone or gravel that may have come to the surface. We have scarified approximately 200 miles of roads during the past season at an average cost of \$75 per mile. The improvement in the highways for travel indicates that it has been well worth the money expended. In some instances new material has been added to the scarified surface and has placed the surface in a condition to be maintained cheaply by the use of a light grader or a road planer.

UPKEEP OF OLD MACADAM ROADS.

The stone macadam roads receiving the heaviest traffic, which is generally near some good market town, have been surface treated as usual whenever possible to do so, but quite a large portion of the stone macadam roads that had been previously surface treated we found it either impossible or impracticable to surface treat this year. The cost of bituminous material combined with unsatisfactory delivery of it has caused us to hesitate to surface treat some of the roads, especially where they were not in proper condition to receive the treatment.

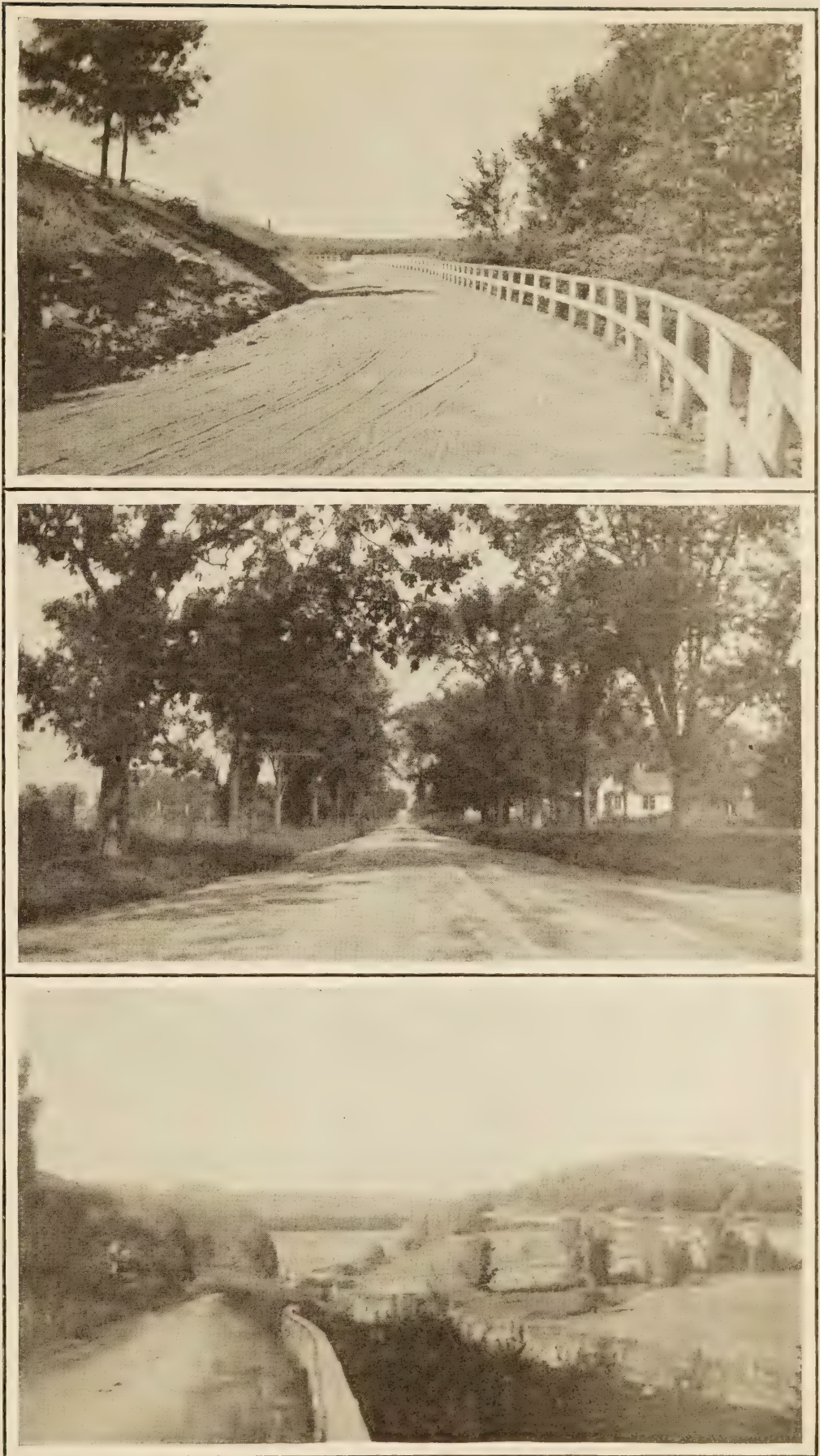
Other methods have been resorted to, one which has been found very satisfactory. That is, by scarifying the old surface to the deepest hole on the surface, shaping up the road to a proper crown which should be reasonably flat, and after having compacted the surface, covering the same with 1½ inches to 2 inches of fine gravel or good sharp sand. In many instances we have placed the covering on the old macadam surface without scarifying and have obtained very good results by this method. When the old surface has been covered with gravel or sand the patrolman can keep it in place by the use of a light grader or a planer after each rain and we find this surface fully as satisfactory to drive on as the surface treated macadams. Concrete roads have been taken care of by the ordinary methods of filling the cracks and joints with bituminous material, covering it with a light coat of

good sharp sand, taking care of the drainage and keeping the shoulder material in place.

SATISFACTORY CONDITIONS.

The condition of the system at the present time, October 24, 1918, is indeed very satisfactory. The earth road sections, due to the persistent efforts of the patrolmen and the gang maintenance crews are now in splendid condition. The speed at which a car may operate over these roads depends largely upon the speed the car can make, as the surface in nearly all cases is very smooth. On the majority of the gravel roads all waves and holes have disappeared and the surface is in much better condition than we expected to get it in one season. A few of our macadam roads where traffic is extremely heavy are probably in no better condition than they were at the beginning of the season, but in the majority of cases we believe they show a decided improvement.

For convenience in handling our road problems the commission has divided the State into eight districts with a division engineer in charge of each district who looks after



WISCONSIN TYPES OF ROAD. TOP—TYPICAL EARTH CONSTRUCTION. CENTER—GRAVEL. BOTTOM—TYPICAL MACADAM.

the construction and maintenance; also in each division there is a maintenance engineer and a force of three or four men who make surveys and plans.

At a recent conference of the division engineers each was asked to state his views as to the increased improvement of the roads in his division due to patrol maintenance. The average estimate of increased improvement as determined by them was approximately 75 per cent. They were also requested to give their estimate of the increase in miles per hour that a traveler could make over the system to-day as compared to a year ago. Each division engineer took some specific road over which he had been accustomed to travel other years and knew the time required to travel between two points, comparing it to the time required between the same points now. The average estimated increase was 8 miles per hour, which is believed to be a very conservative estimate.

LABOR PROBLEMS NOT SERIOUS.

The labor problem, in so far as maintenance work is concerned, is not serious. We have 550 patrolmen and the majority of them are men well up in years, in many cases men who have retired from the farms. A very small portion of our patrolmen have come within the draft age. State aid construction has been cut down to the very minimum in Wisconsin this year, and this has made available quite a large number of men and teams formerly employed on that work, and they have made excellent men for maintenance service.

Many of our counties are using motor trucks for hauling maintenance materials for surfaced roads and in many instances are using machinery for loading trucks, thereby reducing the labor cost. We have several small portable gravel crushing plants where material is delivered to the crusher by team and scraper and is properly crushed and screened, and in many cases is hauled a distance of from 5 to 10 miles, making a very good and reasonably cheap maintenance material. The cost of the work compared with normal years has probably increased to the extent of 40 per cent. However, the increase would be greater if it were not for the fact that in nearly every county motor trucks are being used to deliver maintenance material, reducing the cost for that part of the work from the former cost by team delivery.

TRAFFIC CONDITIONS IN STATE.

The character and volume of the traffic which has a tendency to destroy the road surface is changing and increasing rapidly.

We have some 10 or 12 motor-truck manufacturing plants in Wisconsin that use the roads tributary to their plants for the purpose of trying out new trucks to such an extent that it has a decided bearing

on the maintenance work near those plants. In nearly all instances there is some bad hill near the plant or some stretch of surfaced road that is used for demonstration purposes. Frequently a train of trucks making its way east for delivery use our highways. We also find in some of our earth road sections that timber for war industries has been purchased and must be hauled immediately, and it is not uncommon to see a train of teams with exceptionally heavy loads of lumber making its way across our highways to railroad points. These heavy loads on narrow tired wagons are extremely destructive to the earth roads. Ordinarily this kind of hauling is done in winter months on sleighs. Some is hauled, however, during the summer and fall over our trunk highways. In the lead district, in the southwestern part of the State, we find many of the mining companies have installed heavy motor trucks for hauling the ore to shipping points. Many of them carry 5 tons or more, and this traffic is extremely destructive especially to earth roads.

MILK AND MERCHANDISE TRUCKS.

Wisconsin has 60 large milk condenseries, furnishing canned and condensed milk, with daily receipts at each of from 150,000 to 200,000 pounds of milk. The majority of the milk is delivered to the condenseries by motor trucks. This is done 365 days a year and one can readily see the effects of this traffic on the highways. These condenseries usually haul their milk from a radius of from 10 to 20 miles. Sections over which this traffic goes need intensive maintenance in order to keep the roads in good condition. Many hundreds of creameries throughout the State are also receiving the milk by motor trucks. All this traffic has a tremendous effect upon the surface of the roads traveled.

The number of motor trucks is increasing rapidly in the rural districts. We have in Wisconsin hundreds of small inland towns which buy produce and furnish groceries and merchandise to quite a tributary territory. In nearly all cases the goods are delivered from the railroad to the inland town by motor truck. Many of these small towns have as high as 8 or 10 motor trucks which travel an 8 or 10 mile stretch of road daily with their loads. We notice in some localities that the farmers are hiring these same trucks to deliver their hogs and cattle to the market. This traffic naturally affects the maintenance of the highways to a marked degree.

We are all well satisfied with the patrol system of maintenance on our 5,000-mile system after this season's trial. We are so well pleased with results that the Wisconsin Highway Commission hopes to induce the county board of each county to adopt a secondary or county truck system and install patrol maintenance on this secondary system. In fact,

some of the counties have already done so. If this were accomplished it would place practically all of the main roads of the State in first-class condition to travel throughout most of the year.

KEEPING UP CLAY AND SAND ROADS.

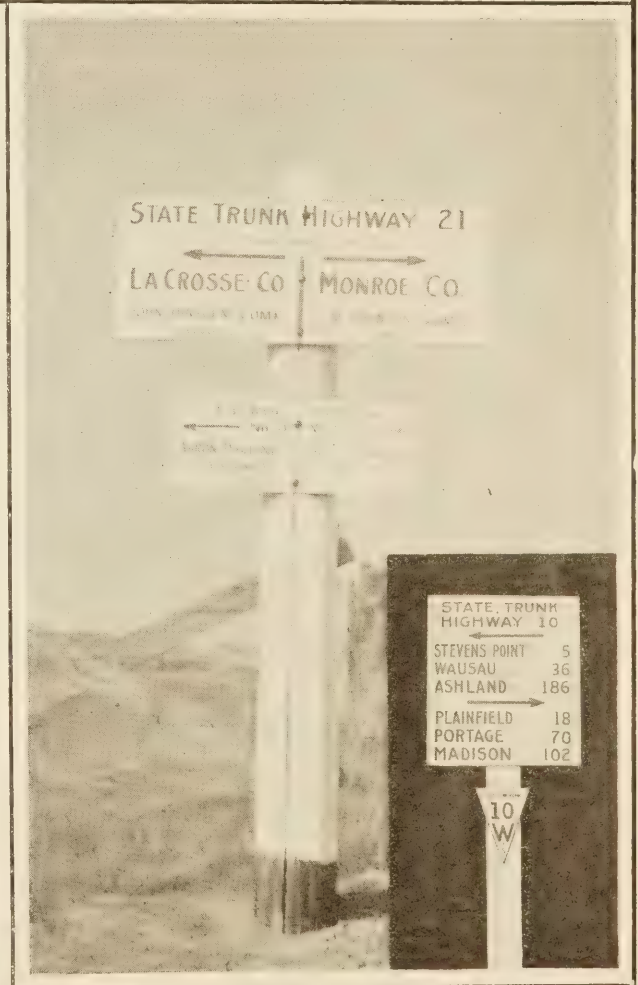
We find that a heavy clay road can be made a good road to travel almost every day in the year by adding 2 or 3 inches of sandy gravel or even sand if the gravel can not be obtained. We would not advocate this, however, unless the road so treated is maintained by the patrol system. Two or three inches of gravel will not hold up the traffic immediately but if gone over after each rain with a light grader or planer, in a short time the surface of the road will become so thoroughly solidified that it will maintain the traffic in a reasonable way. Any holes appearing that can not be filled with a light grader will be filled by the patrolman with new material. By this method the clay roads can be maintained in a very satisfactory manner.

Our sandy sections are being taken care of by pushing out the old worn-out sand from the center of the road and moving in with a road grader new unused top soil from along the roadside, making a fairly satisfactory wearing surface for light traffic. In some instances, clay, shale, or gravel must be placed on the surface before the sand road can be considered satisfactory.

Wisconsin now realizes the importance of proper maintenance of public highways and it is certain that no reaction can set in so as to make the State take any backward step in the movement for highway maintenance.

CONCLUSION.

After the Civil War closed, railroad construction and maintenance developed by leaps and bounds. Distribution facilities were lacking and our people gave large thought and attention to developing our steel highway system. With the winning of the war for democracy, the people of this country will again give serious attention to methods of distribution. In early times tribes and clans were satisfied with living unto themselves. Their food and clothes were produced in their homes. How different are the economic and social conditions of today.



TOP—STANDARD HIGHWAY MARKER ON WISCONSIN ROAD.
BOTTOM—COUNTY LINE AND PATROL SECTION SIGNS.

Little of the necessary food and clothing of mankind are made in the community in which we live. Production, transportation, and distribution are the



TRAFFIC ON WISCONSIN ROADS—HAULING MILK IN MILWAUKEE COUNTY. TRUCK WITH TRAILER
HAULS 128 CANS DAILY, OTHER TRUCKS 75 TO 100 CANS.

economic problems that must be understood and more satisfactorily solved by laymen as well as by legislators. Wonderful have been the improvements in the last century along all lines of engineering. The man of the hour is the engineer. The man of the future will be the engineer. In no one line of activity has there been need of advancement in modern times as in the needs for transportation. Good roads well maintained are essential to the advancement of our people commercially, educationally, and socially. Good roads mean education and liberty while poor roads mean illiteracy and bondage. The roads have been fairly well laid out all over this State and Nation, but the one thing lacking up to the present time has been proper maintenance. Maintenance of wagon roads is the problem needing large attention. Wisconsin has

worked out a program that has already given excellent results and promises much for the future.

HIGHWAYS THE BAROMETER OF PROGRESS.

There is exhibited throughout Wisconsin a more progressive good road spirit than has ever been known before. It is recognized everywhere that a community's prosperity and happiness can be estimated by studying highway maintenance. It is said that a community's cleanliness can be determined by the amount of soap used. It is also true that a community's progressiveness can be determined by the condition of its highways. Wisconsin has blazed the way with a new method of road signs or road markings, and established a practical up-to-date policy of road maintenance, worthy of favorable consideration everywhere.

Connecticut Paid More for Its Labor and Saved by Using Motor Vehicles.

By C. J. BENNETT, State Highway Commissioner.

THIS State has a mileage of roads aggregating approximately 1,500, including all types of construction, from city pavements to the ordinary graded earth road. In general the condition of these highways in the spring was as usual, namely, the hard pavements were in splendid condition; some of the waterbound macadam roads were broken up badly and the earth and gravel roads were muddy and broken through as usual. There was some increase in the difficulty experienced due to the increase in heavy truck traffic

through the past winter and spring, from which resulted the greatest amount of damage, but in general, it does not appear that there will be any marked increase in this class of traffic over that of last winter and spring.

In general our roads are in good condition after the summer maintenance. We find that they have not deteriorated any more than would be consistent with continued use.

The labor problem was solved by increasing the price paid to laborers, competing in many instances

with industries employed on war work where the cost of labor was a secondary consideration. As an indication of the difficulty met in this matter, please note the following comparison between the cost of trunk line repairs of approximately 1,000 miles of road, during 1916-17 and the cost of the corresponding year 1917-18:

Cost, 1916-17.....	\$559,341.74
Cost, 1917-18.....	679,453.46

These figures are almost a direct comparison showing the increased cost of labor. Material is not included.

Our experience with materials during the summer of 1918 was extremely gratifying. As a matter of

fact, we had very little delay on account of the shortage of materials.

Realizing that the use of time and labor-saving devices was imperative, the department purchased an increased number of motor vehicles for the transportation of men and materials, and also increased its facilities for distributing bituminous material by truck, through the purchase of four large tank trucks. In addition, mechanical loaders and spreaders for the covering material were employed.

Following the custom inaugurated a year ago, this department has made careful plans for the removal of snow and the proper maintenance of traffic during the coming winter.

Machinery and the Patrol System Solved Utah's Maintenance Problem.

By IRA B. BROWNING, State Road Engineer.

THE public roads in Utah have withstood during the current year an abnormal traffic under unusually severe working conditions. The protracted storms of early spring developed the the instability of those sections that lack proper foundations and adequate drainage. The protracted drought of the late spring and early summer reduced the strength and resistance of the clay-macadam and sand-clay surfaces, and the increased tonnage resulting from the campaigns for greater production, the additional local highway traffic to relieve railroad congestion, and the enormous loads commonly transported by heavy trucks, have added unusual burdens to the highway systems. Even the hard surfaced roads that have heretofore resisted the traffic satisfactorily have shown pronounced wear and disintegration under the added burdens.

The shortage of available labor has increased the difficulty of making repairs when needed, and the increased costs and labor charges have added greatly to the expense of maintenance.

MODERN EQUIPMENT INDISPENSABLE.

In some cases the imperative need of maintaining the roads in more serviceable condition, under an ever increasing traffic, heavily loaded vehicles, made necessary the relocation of sections of the roads, abandoning the insecure foundations and unsuitable road materials in favor of better locations and more durable road materials. For this work, the steam shovel and other modern road building equipment have proved practically indispensable.

Not only does the use of such equipment result in an immense saving of cost, but it makes possible road construction where teams and men can not be secured. Where costs have been kept on such work in Utah, the range has been from 10 cents to 25 cents per cubic yard of material, generally a mixture of earth, rock waste, and bowlders, in about equal proportions, which would cost from 30 cents to 75 cents per cubic yard by team and man labor, at current wages.

The maintaining of roads has also necessitated the grading and crowning of certain sections. Here again the motor-drawn equipment has demonstrated its value. A typical case was the grading of a road in Utah County, using a heavy grader drawn by a tractor. The total cost was less than \$30 per mile, where with horse-drawn plows, scrapers, and graders, the expense would have been at least \$150 per mile for the same road.

The use of the road scarifier drawn by either a truck or a tractor, for reducing the irregularities on a gravel or macadam road, and providing a bond for new surfacing material, affords another illustration. The steady pull on the drawbar of a tractor or large truck, together with the uniform speed and the perfect control, render the operation of scarifying roads with power-drawn equipment twice as effective as when horse-drawn implements are used, and much less expensive.

The use of portable compressors and jack-hammer drills has done much toward reducing the time and labor for cutting out defective areas and patching and maintaining hard surfaced roads; also for the removal of intrusive points of ledge rock and the bowlders encountered during excavation.

PATROL SYSTEM MOST EFFECTIVE.

The maintenance of earth and shale or gravel surfaced roads is becoming more of a problem as the traffic and intensity of loading increases. The labor of repairing and maintaining these highways is therefore sure to increase. It has been demonstrated in Utah that the greatest saving and improvement is effected by establishing a patrol system for the main roads. If a foreman residing along the road has a 10-mile section, extending each side of his home, and he is authorized and encouraged to plan ahead for the requirements of his road section, he will have piles of material suitable for repairing ruts and maintaining the road surface in good condition, at convenient points along the road. He will so plan his work that the grading, crowning, dragging, and draining of the roads will be attended to at the proper time, even though this may be outside of the ordinary working hours. Allowing a road section foreman the initiative and placing upon him the responsibility of maintaining his road in commendable condition for traffic, has proved, where the foreman had ambition and capacity, the most economical and effective system yet devised and tested in this State.

The present plans of the State Road Commission include a power unit, such as a tractor or heavy

truck, for each county; also the extension of the road patrol system to cover all of the principal State roads.

My conclusions from the year's work are:

1. Maintenance of earth roads under the most severe weather and traffic conditions is most easily accomplished where the native material within the roadway limits and to a considerable depth is a durable and suitable material.

2. Under extreme conditions an inadequate depth of surfacing material on an insecure foundation is practically worthless, as the breaking down of the road surface in spots may render the road nearly impassable. It is far better to provide adequate thickness of suitable surfacing material.

3. The road patrol system for hard surfaced roads, macadam, and earth roads, has proved to be the most effective method of maintaining highways under heavy traffic.

4. The solution of the labor problem in road building requires the use of modern machinery and equipment handled by competent workmen.

5. Just as increased burdens must now be borne by each community with a large percentage of the most active members in war industries or military service, so each highway department must now accomplish more at road construction and maintenance, under heavier traffic burdens and with a more pronounced shortage of materials and labor than ever before. The absolute requirement is therefore an efficient organization for road building and maintenance, and modern types of roads and equipment.

Keeping up Roads in the District of Columbia for War Traffic

By COL. J. J. LOVING, Assistant to Engineer Commissioner.

THE wear upon the surfaces of nearly all of the roads and streets within the District of Columbia during the winter of 1917-18 and since has been excessive, due to the various war activities in the city of Washington and adjacent territory, which included the construction of many new office buildings, two army cantonments, one munition factory, and one large base hospital, within the District, and two very large cantonments within a short distance of the city. A great shortage of labor and, to some extent, embargoes on shipments of materials have interfered seriously with the prompt repair of the roads and streets. Due to these circumstances it has not been possible to keep the surfaces in first-class condition, but by persistent and continuous efforts they have been maintained in a passable though rough state and in the fall were vastly better than in the spring.

RESURFACING MACADAM NECESSARY.

The greatest difficulty was found in maintaining the macadam roads having oil and tar surfaces; and the Bladensburg Road, which is the main line to Baltimore and Camp Meade, has been almost completely resurfaced twice during this season. The numerous openings and cuts for new construction also greatly increased the amount of work.

Many laborers deserted us for better pay under contractors engaged on the cost plus percentage basis, and their places could not be filled, although wages were advanced during the year about 80 per cent. To offset the loss of labor, machinery was used to a larger extent than ever before, and in grading, however light, steam shovels were employed.

Materials were supplied in limited quantities for repairs only, through the valuable assistance of the

United States Highway Council and the Railroad Administration.

THE COST OF WORK IS DOUBLED.

The cost of work done by contract has been doubled during the year. When done by hired labor the advance in cost was about 80 per cent more than a year ago.

The increase in destructive traffic was mainly caused by the greatly increased use of heavy automobile trucks for hauling construction materials and for army transportation. The use of passenger automobiles was also very largely increased, and it is probable that the traffic endured by the roads as

a whole was at least doubled, and in some cases was quadrupled.

The use of bituminous patching material which could be mixed and applied at ordinary temperature to the surface-treated roads has been the principal method employed in maintenance of the macadam roads. The work done ranges from patching to entire reconstruction at the worst places.

It is proposed to continue the maintenance with the entire force that can be secured for the purpose as long as the weather and the state of the roads will permit; and it is hoped by this means to keep the roads and streets in passable condition, though it is not expected that it will be ideal during the continuance of the state of affairs now existing.

Maine's Portable Maintenance Crew Big Factor in State's Upkeep Work

By PAUL D. SARGENT, Chief Engineer.

AT the opening of the spring season this year the main highways were in about their usual condition. As there is substantially no war activity in this State, outside of shipbuilding at Portland and Bath, no extraordinary traffic was brought upon the highways to injure them during the winter and more particularly during the period when frost is leaving the ground and the roads are settling.

The principal types of surface employed on our State highway system are Portland cement concrete, bituminous macadam and gravel, about 80 per cent of the surface being of the latter type. We have two short sections of water-bound macadam surface treated. All of these roads came out of the winter in as good condition as ordinarily they do. About 100 miles of the gravel-surfaced State highway which receives the heaviest traffic has been surface treated with tar during the last four years, and these sections came out in very good shape.

BITUMINOUS MATERIAL SECURED.

Anticipating that there might be some difficulty in securing materials for surface treatment, this commission placed orders as early as January and February, 1918, for their requirements for the year. About two-thirds of our normal supply of bituminous material for surface treatment was delivered in barrels and arrangements were made with the railroad companies to have this unloaded at some point in their yards where it would cause no interference with ordinary yard work and where the material could be loaded into wagons or motor trucks. Ordinarily this material would all have been taken in

tank cars. While the cost was about 20 per cent more for the material in barrels than it would have been in tank cars, when the season opened we had the material. The remainder of the material needed was received in tanks, although the order had originally been placed for barrel delivery.

HOW LABOR PROBLEM WAS MET.

Considerable difficulty was experienced in securing labor for maintenance work. During the last two years we have maintained a sort of portable maintenance crew, that is to say, we have had about a dozen men whom we have transported from place to place on the State highway system, and with this crew surface treatment work and resurfacing work has been done. In the past we have held the nucleus of the crew together and boarded them around at different places, depending on filling out the crew with local labor at different points. It was absolutely impossible to do this this year, so we organized a portable camp consisting of two large living tents, a cook tent, a dining tent, and a supply tent. By this means we were able to keep the men right on the work and held a crew of about a dozen men together through the whole season. There were a few changes in the crew, however. We paid this crew \$2.50 and \$2.75 per day and board and gave them straight time. This crew was supplied with six motor trucks and we had very great difficulty in holding motor truck drivers. Probably we have had not less than 25 to 30 drivers in this outfit this year, those whom we have lost being practically all drafted.

THE INCREASE OF HIGHWAY TRAFFIC.

A traffic census taken at 19 stations at various points on the State highway system during the first week of September in 1918 showed a gross number of vehicles of all kinds of 59,087. At the same stations in 1917 the gross number of vehicles moving during the same week was 56,264. The maximum number of vehicles in one 12-hour period in 1918 was 3,585, and the average number of vehicles at this station for the seven-day period was 1,585, and at the same station in 1917 the maximum number of vehicles was 1,931 and the average for the seven-day period was 1,373. At another station the maximum for 1918 for the 12-hour period was

1,704 with an average of 1,140 for the seven-day period, and in 1917 the maximum was 1,649 and the average was 1,095. These increases in traffic represent approximately the increased number of automobiles registered in the State, but it is fair to note in this connection that tourist traffic during the months of June, July, and August was much lighter this year than it has been in ordinary years. The total registration for automobiles for the year up to October 6 was 40,069 against 37,336 for the corresponding period in 1917, and the total registration for trucks during the year up to October 6 was 4,101 against 3,271 for the corresponding period of 1917.

Pennsylvania Spends \$4,500,000 in Keeping Roads Up to Standard

By J. DENNY O'NEIL, State Highway Commissioner.

PENNSYLVANIA roads have had to bear their full burden of the war, but like Pennsylvania in all war emergencies, it has been equal to the task. Pennsylvania roads have had to bear the burden of more Army trucks and more trucks loaded with munitions and supplies than any other State in the Union. We have approximately 1,000 miles of roads which can be termed war roads, or roads that are being used by Army trucks or by Government trucks for the transportation of munitions and supplies. Many of these roads were constructed several years ago and at that time no one even dreamed that they would be called upon to carry loads of 10 and 15 tons, therefore the question of maintenance has not only been a big problem but a very expensive one. Some idea of the cost of this work can be conceived from the fact that we spent over \$600,000 for maintenance and repairs on the Lincoln Highway alone, while the total amount spent for maintenance in the State exceeded \$4,500,000.

STONE CRUSHERS AT STRATEGIC POINTS.

During 1917 we had trouble getting material for maintenance on account of the congestion of the railroads and on this account we decided late in the fall to open up quarries and place stone crushers at strategic points throughout the State where we could deliver stone upon our important roads by trucks: 75 quarries were opened and this plan has proven very successful as we not only produced the stone at a saving in price but we had the stone ready when we needed it. This year we were very fortunate in securing bituminous material for road treatment and I am glad to say that our roads now

are in splendid shape and ready for the great strain which they will have to endure during the coming winter.

Throughout the coal regions thousands of small mines have been opened and this coal is delivered to shipping points and industrial centers in wagons and in trucks. Some idea of the magnitude of this business can be formed from the fact that Altoona was supplied with coal in this manner and many of the large industrial plants in the Pittsburgh district are supplied entirely by wagons and trucks. Roads used by coal trucks have been very hard to maintain, but with very few exceptions we have been able to keep them in good shape.

We have been very successful in securing labor for road work this year by establishing commissaries and by assembling men in the rural communities at various points and transporting them, to where the work is in progress, in State trucks.

We have found that the average cost of maintenance including labor and material has been about double that of normal years.

DISTRIBUTION OF TRAFFIC BY TRUCKS.

Truck transportation has been growing by leaps and bounds, practically all of the wholesale houses and many of the manufacturers in the large industrial centers throughout the State are now distributing their products within a radius of 20 to 30 miles by trucks. Several express and freight truck routes are now established and run daily in the eastern and western part of the State. During the past year thousands of families have moved from various localities to industrial centers where war work is in progress and with very few exceptions all of these

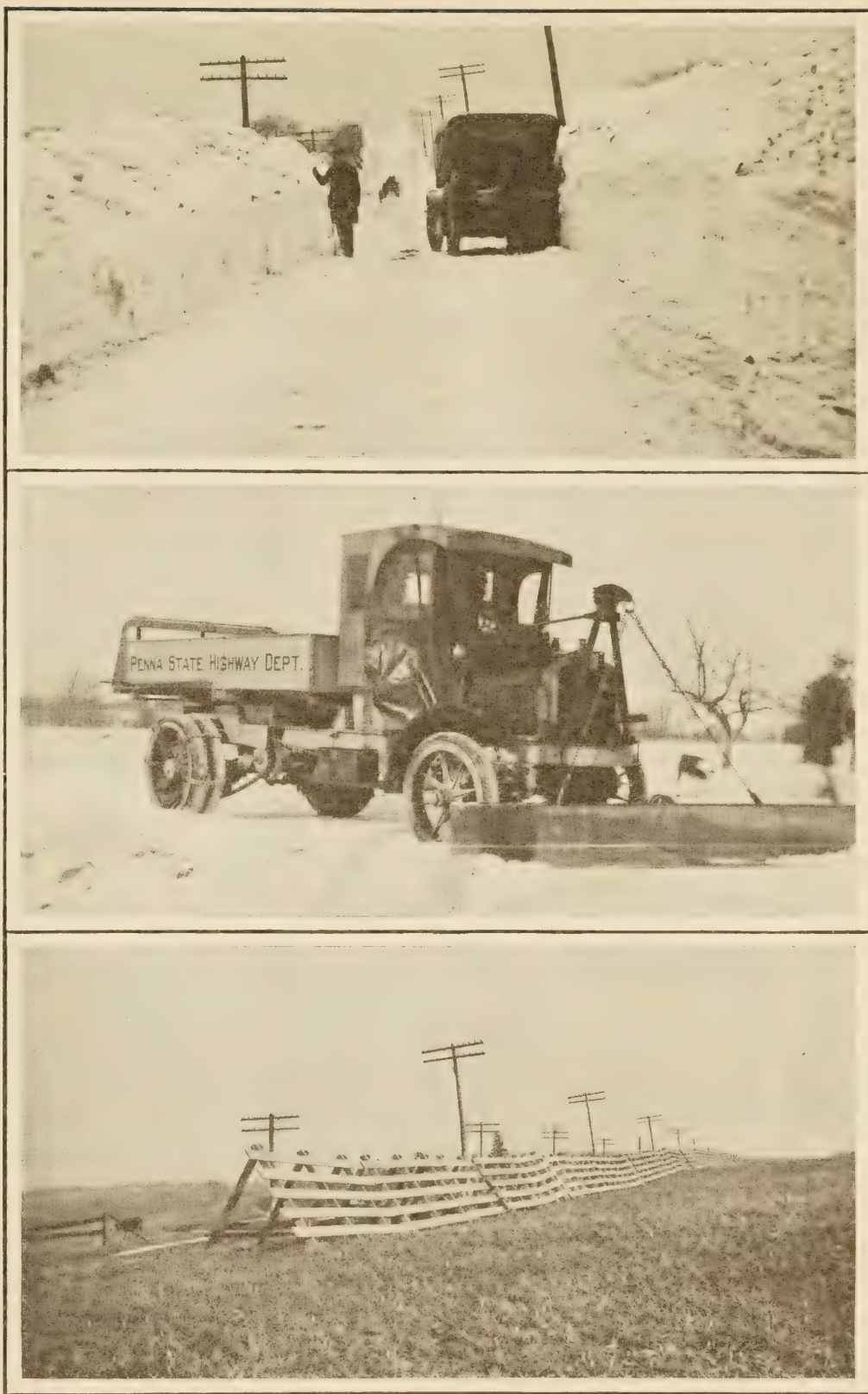
movings have been transported by trucks, and this has made an additional burden for our roads to carry.

One of the most interesting war roads is the 12 miles in Beaver County from the Ohio State line to Beaver Falls. When the Government selected this route as the one that they would move their army trucks over it was one of the worst earth roads in the State, several miles of it running through a regular swamp. This spring we undertook to build a slag road and in some places we had to put as much as two feet of slag on before we could get a good foundation. This road was constructed with our State forces. We have placed a water-bound top on it. This completes a hard surface road throughout the entire State of Pennsylvania from the Ohio State line to the New Jersey State line, a distance of 360 miles.

SOLUTION OF THE SNOW PROBLEM.

One of the big problems brought about by the war is that of keeping our main highways, particularly through the mountain sections, open for the transportation of army trucks and trucks loaded with supplies, during the winter. We succeeded in doing this last winter, notwithstanding the fact

that it was one of the coldest and most severe winters ever experienced in this State. Last fall we equipped many of our 5 ton trucks with snow



FIGHTING SNOW ON PENNSYLVANIA ROADS. TOP—DRIFTS CLEARED FROM BEAVER COUNTY ROAD USED BY GOVERNMENT TRUCKS. CENTER—SNOW-PLOW TRUCK ON ADAMS COUNTY HIGHWAY. BOTTOM—SNOW FENCE ON LINCOLN HIGHWAY IN BEAVER COUNTY.

CONTRACTS LET FOR 71 NEW ROADS.

We have awarded contracts for 71 roads, practically all of which connect county seats or industrial centers and are roads which will form part of a definite system. In almost every instance we have been successful in getting the local authorities to pay half the cost. The roads are located in 33 counties; the total mileage of new construction is 150.52; the total amount of money involved is \$5,407,678.87. The contributions made by the local authorities plus \$567,360 Federal-aid money totals \$2,356,929.01, this leaves a balance of \$3,050,749.76 to be paid for by the State. The types of construction are as follows:

Reinforced and plain concrete.....	43
Brick on concrete base.....	18
Water-bound macadam.....	2
Bituminous macadam.....	1
Bituminous concrete.....	2
Asphaltic block.....	1
Grading and drainage only.....	4
Total.....	71

Motor truck transportation is just in its infancy; manufacturers, farmers and men in every line of business realize the importance of well constructed hard top roads, and in my opinion after we lick the Kaiser Pennsylvania is going to enter upon an era of road building which will not stop until the entire State is linked up with a system of improved roads.

Dragging System Main Feature in Caring for Kansas Earth Roads.

By GOV. ARTHUR CAPPER, Chairman Ex-Officio, Kansas State Highway Commission.

ROAD construction in Kansas under the supervision of the State began about one year ago. After some months of investigation and holding hearings with the people throughout the State, the highway commission established a system of about 6,500 miles of State roads.

The constitution of Kansas forbids State aid in any public improvement and therefore the commission had no financial inducement to offer to the people except Federal aid. They adopted the policy of offering 15 per cent of the total cost of the road, having in view that the people would build the roads if they felt the necessity and saw the benefits derived.

War conditions brought about a stringency of labor and enormous increase in the cost of materials to such a rapid extent that construction was almost out of the question. However, the commission continued to receive applications and has passed upon a number of projects.

THE DISTRICT BENEFIT PLAN.

The Kansas law permits the construction of permanent roads by a benefit district plan. After the Federal aid has been deducted, the road may be constructed upon petitions from the people to the board of county commissioners. If they declare it a public utility, the county pays one-half the cost of construction, the townships through which it passes pays 25 per cent, and the benefit district pays 25 per cent. The petitions specify the bounds of the benefit district, but as a rule it extends about 1½ miles on each side of the road.

Up to the present time petitions have been granted for about 550 miles of hard-surfaced road at an estimated cost of \$7,500,000. It is hoped to begin construction on a number of these projects as soon as the war situation brings the commercial life to a more normal condition.

Kansas farm products this year are valued at approximately \$550,000,000 and the transportation of these products to market has been handled almost exclusively over earth roads. In many cases the truck took the place of teams. While the man power is short in the road-dragging feature, machinery has been substituted in a great many cases and a larger number of miles could be dragged than when using horses.

MOTOR FEES TO DRAGGING FUND.

The State of Kansas this year will raise approximately \$875,000 from the license fees on automobiles. By State law this entire fund is to be used for road dragging, and yet in a number of instances it has been impossible to secure the man power to expend this fund in an expeditious manner.

Kansas has a law whereby the county prisoners and prisoners in the State penitentiary may be utilized for road construction, but, as is well known, a large majority of the counties do not have any prisoners in their county jails and those in the State penitentiary are used in the binding twine plant and coal mines owned by the State.

The road-drag fund can be used by the counties in removing snow in the winter time as well as

smoothing down the ruts after a rain. This method was very successfully carried out in several counties last winter.

PATROL SYSTEM IS NECESSARY.

The experience of the past year gives added evidence to the fact that road maintenance, whether on an earth road or a hard surfaced road, must be handled through patrolmen, taking a definite territory, instead of depending on the farmers who are so busily engaged in other affairs. The counties of the State are investing very generally in trucks and stone crushers. Many counties find that they have fine deposits of gravel that have been unnoticed through the years and these counties are making large plans to have an extensively constructed system of gravel roads covering the entire county.

While this State, next to Texas, has the largest road mileage of any State in the Union, and has been rather negligent in planning a systematic, concerted method of road construction, the experience of the past year shows that she now has the matter well in hand and will rapidly construct highways which will aid materially in the transportation of the extensive crops for which this State is noted.

Use of Local Materials and Patrol System Help Much in Michigan.

By L. H. NEILSEN, State Maintenance Engineer.

MOST of our roads have a gravel or water-bound macadam surface. There are no roads maintained directly by the State.

Due partly to favorable weather conditions the gravel-surfaced roads came through the spring in very good condition. Labor shortage and difficulty in securing rail shipments made the task of maintaining the roads an unusually hard one. A long dry period caused unusual raveling of the surface which did not improve conditions. These difficulties have to a large extent been met by the use of local materials and the development of the patrol system. Wherever adopted and faithfully worked out marked economy of labor and material have resulted.

FLOATING WORTH THE COST.

It has been demonstrated that floating with the ordinary steel or wooden floats even in dry weather is well worth the cost. Indeed on some high traffic roads daily floating regardless of weather conditions has been found necessary to preserve the surface even in fair condition.

In cases where this is necessary constant application of new material has been found most satisfactory.

This gravel should contain no material passing a one-half or three-fourths mesh and should contain 30 per cent to 40 per cent of material passing one-eighth mesh. It should be placed in thicknesses not to exceed 1 inch in thickness and should be replaced as often as is necessary to insure that some loose gravel is always present. There must be some material loose on the surface if dry floating is to be of any benefit.

Mechanical power for floating has not been an entire success because of the tendency of the operators to go too fast.

Local materials are being utilized more than ever.

SURFACE TREATMENT GIVEN.

Car shortage made it extremely difficult to secure crushed stone or chips for water-bound macadam maintenance. Two methods were used on such work. On a large number of miles of water-bound limestone macadam surface treatments have been given. Cold bituminous material is applied at the rate of one-half to three-fourths gallon per square yard. This is put on in two coats and the last treatment is covered with sufficient chips or pea

gravel to take up any excess material. Slag chips have been used very successfully for this purpose.

The same method has been used to some extent on water-bound cobblestone macadam and on gravel roads.

Surface treatment of those types of roads has not been so successful, due mostly to the fact that they can not be swept entirely free from loose material without endangering the bond of the road itself. In some cases fair success has been obtained, especially where gravel roads have been built of gravel substantially by macadam construction methods.

Very satisfactory results have been secured by the use of a low test gravel containing a very small amount of clay or loose filler. This material is put on in sufficient amounts to fill holes and ruts and leave enough material to float. The road is then maintained by the patrol system using the same methods that are being used on gravel-surfaced roads.

NEW TRAFFIC PROBLEMS.

Traffic increases are due to increasing use of motor trucks for inter-city transportation and for transportation of farm products from farm to market.

The large increase was observed in driveaway deliveries of passenger automobiles and trucks. Due to the decrease in the output of pleasure cars driveaways of that class of vehicles is decreasing very rapidly. Motor trucks both war and commercial are being delivered under their power in ever increasing numbers. War trucks are being driven away loaded.

The State highways transport committee is engaged in organizing motor express routes. These will place a still heavier burden on our highways which can only be met by more intensive maintenance. This must be accomplished by more general adoption of the patrol system and by careful development of the systems already installed.

Machinery and Local Materials Factors in Colorado's Big Problem.

By T. J. EHRHART, Colorado State Highway Commissioner.

OTHER States have seen their highways torn to pieces by the heavy truck traffic during the present season. Colorado had this and the forces of nature as well to contend with.

When the spring of 1918 rolled around the roads of this State were in generally good condition. Composed for the most part of a heavy gravel in the mountain districts, mixed in with patches of adobe, the range highways passed through the winter season in generally good shape, the snow very frequently serving as a binder which really made the highways better.

In the eastern section of the State where the roads for the most part consist of gravel-surfaced highways, the same statement was true and until the year was well under way the State highway department and the county commissioners generally anticipated a comparatively light season of maintenance.

MACHINERY BOUGHT IN ADVANCE.

With the war in mind, however, general preparations had been made to meet unusual conditions. Thus many of the counties had taken up the subject of road machinery for the first time and heavy purchases of graders, scarifying machinery, trucks and other labor-saving devices were made.

Investigations into comparative costs had shown that the four-horse grader was an efficient unit on the plains, while six horses were sufficient to carry the burden of toil on the heavy mountain grades.

These machines linked up with the tractors of the State highway department gave the road officials a dependable battery of equipment with which to face the year's campaign and certain it was that last spring found Colorado better equipped for road building than at any time in past history, despite the fact that every indication pointed to a sharp curtailment in the labor available for this work.

What followed is one of those chapters in road building which can not be foreseen and the full meaning of which can only be appreciated when the book is finished.

HARD STORMS DESTROY ROADS.

To begin with, an abnormally early hot-weather spell set in in the mountain country. Snow sheds which ordinarily carry their moisture well into late summer were released in June and by July the steady drainage of the higher peaks had settled down into a virtual flood. In every mountain district of central Colorado the rivers reached the highest levels of 30 years' tabulation, sometimes exceeding the memory of the "oldest inhabitant" and at once devastation of the highways began.

Bridges which had survived the highest waters of other years were torn from their bases and tons of metal and timber were carried downstream by the savage onslaught of the waters. Highways tucked away on the shelves of the hills were buried under the steadily rising streams, miles of road were washed out

and from every county arose a call for aid from the State highway department.

Colorado's annual road appropriation amounts to only \$80 per mile and naturally the sum was not enough. But the task was to be done and State and county officials set their teeth and went to it. Crews were temporarily called off construction work and put on maintenance. The counties scraped together every cent they could raise and sent men out on the roads. Within a short time the imperative demands were met and the roads were opened for traffic. Later, as opportunity offered, aided by a natural return to usable conditions as the sun got in its work, the less urgent conditions were taken in hand.

TEMPORARY REPAIRS WIPED OUT.

All might have been well had nature been content. But the old lady was not in a smiling mood and frowns were followed by tears. In midsummer, contrary to all past experience, fall rains set in and for weeks the State was deluged by a steady downpour.

Out went the temporary repairs on the roads, down went the bridges, and in a fortnight not only had the repairs been wiped out but material damage had been added in the eastern section of the State which had escaped the troubles of the earlier season. Altogether fairly close estimates place the bridges lost at 125, while a conservative estimate of the total damage done amounted to \$500,000.

On top of this the war had taken most of the younger road builders, the farmers needed every man they could get to harvest crops, and such labor as could be secured was of the kind which gives



ROAD ALONG THE UPPER ARKANSAS RIVER, NEAR SALIDA, COLORADO, BLASTED FROM SOLID ROCK AND COMPOSED CHIEFLY OF DISINTEGRATED RED GRANITE.

only about 50 per cent efficiency, requires a high wage, and finds fault at every possible occasion with every phase of his work.

Naturally the situation was not a pleasant one and to make it less so, commercial arteries of the utmost importance in the transportation of foodstuffs were among those most seriously damaged. Immediate attention was given these roads, with the result that the continuance of the rains made necessary reconstruction as often as two or three times on some stretches which have never suffered in the past.

Waterspouts cutting through arroyos were responsible for this, and as there are miles upon miles

of road in Colorado which still follow the old freighting routes because such routes have been passable and funds have been needed elsewhere, it followed that in many cases new locations had to be made.

This, then, has been the situation in Colorado during the year, a situation which has been constantly aggravated by the fact that an intensive campaign for the development of motor truck transportation in this state has resulted in the formation of 100 new motor truck lines with the subsequent addition of hundreds of heavy motor trucks.

On top of this the added cost of passenger travel on the railroads resulted in the early part of the season in an actual and heavy increase in passenger travel on the roads despite the war. Travel generally was less, but the roads drew more than their share on the basis of past years, and everywhere in the State there was a constant demand for maintenance and improvement.

The cost of road work took an enormous jump. In one case that of the Federal aid project on the Jarr Canyon road, the construction work exceeded the estimates by 70 per cent, and in every instance there was a very marked rise in prices due to labor and cost of materials.

LOCAL ROAD MATERIAL SUPPLY.

The fact that Colorado has so much natural road material of the finest quality was in our favor and comparatively little use of the railroads was necessary. A good general supply of culverts was on hand and the type of steel used in most bridge work in the State was obtainable. Box culverts were used in some instances, but for the most part it was found possible to keep maintenance to standard.

The forethought exercised by county officials in purchasing machinery served to very marked advantage in the work and in consequence of this provision, together with a very general increase in road levies made last November, Colorado's highways are to-day open for travel and at the present moment generally better than they were even at the opening of the season.

Just now the question which is most disturbing State road officials is that of the future. Toward the end of the season there was a very marked decrease in passenger traffic, which has reached

probably a diminution of 50 per cent already and which will probably continue on a downward curve until conditions brought about by the war changes. But the motor truck travel is showing an increase, and, as all road officials know, one motor truck is more to be feared than 50 passenger cars.

PLANS MADE FOR THE FUTURE.

Plans for the government of this traffic as now outlined by the State department include the introduction before the legislature of traffic regulations with stiff penalty clauses attached, which will give this office power to regulate width of tires, capacity of load depending upon character of road and speed of travel.

Other bills looking to an increase in the highway fund which will enable the department to meet the Federal aid act without dipping into the present appropriation will be drawn up, and finally every county commissioner in the State has been urged to maintain his road levy at either the present figure where it is already high or to increase it where it is below the average.

The department in these instances is proceeding upon the theory that restricted railroad transportation will add materially to the volume of traffic upon the roads and that adequate maintenance will be essential, in view of the fact that every nerve is now being strained to the utmost development of the enormous natural resources of the State, including radium, tungsten, the metalliferous ores, stock, produce, sugar, coal, and manufactured products.

This can only be accomplished in the coming year by an increased use of machinery on the roads to offset labor shortage, by the use of home manufactured road material to offset transportation restrictions, and finally by larger funds to meet increased costs.

All of these conditions have been discounted already and unless the State has another abnormal season such as the past one inflicted upon it, Colorado will "carry on" with all of the other States of the Union. Should 1919 imitate 1918 then we will simply have to go further than our situation will allow us to, but the roads will be kept open right down to the finish.

Little Maintenance Work Possible in Kentucky and Roads Suffer.

By RODMAN WILEY, Commissioner, Department of Public Roads.

THE majority of the main highways of Kentucky are built of water-bound macadam. Their condition in the spring of 1918 was bad, as many holes and raveled

sections had developed; but on the whole there had been no actual breaking through of the surface, which was due principally to the excellent foundations.

The roads at this time are worse than they were in the spring. Very little repairing has been done and no organized maintenance has been possible. This department has repeatedly urged the counties to repair the roads but the results have been most unsatisfactory.

No law has been in existence allowing the department to enforce maintenance previous to this year and so far as this department is concerned we will not have power to force the counties to maintain their roads until next year.

The labor problem has not been met. Work on a large scale can not be attempted. Convicts have been used as much as possible and we have, this year, used as many convicts as the law permits money to be expended in doing work in that way.

We have met the material problem by using local material whenever possible or else by simply grading the roads and leaving the metal work for future time.

COUNTIES PURCHASE MACHINERY.

No special labor saving devices were developed. The department purchased a steam shovel for convict labor work, as well as purchased and used as many trucks as were needed. Many of the counties also purchased trucks and other modern road machinery.

Costs were from 25 to 35 per cent higher than in previous years but most of the contracts were old ones, let previous to the war and the State law permitted no adjustment of prices, consequently there has been some litigation and a general dis-

arrangement of construction work as contractors did not care to operate at a loss.

Traffic increased considerably due to transportation of automobiles and automobile trucks to the South over the roads rather than by rail. Truck and wagon traffic increased because of the exceptionally large crops of food products and tobacco. The traffic increase during the spring, summer and fall was about 25 per cent for wagons, 50 per cent for automobiles and 50 per cent for trucks.

There is no special necessity for making provisions for keeping roads open this winter as we do not anticipate any great volume of through hauling and snow conditions are mild as a general thing.

If it had been possible under war conditions to allow shipment of bituminous materials for surface treatment of macadam roads, it would have decreased the need of stone shipments in cars. One car of oil used for surface treatment will, in a number of cases, save as much as 50 cars of stone which would have to be used for resurfacing. Under all circumstances the use of local materials should be encouraged. I would suggest also that legislation be enacted to allow all men confined in State penitentiaries and county jails to work on the roads. The use of labor-saving machinery should be strongly urged, elevating graders, steam shovels, stone spreaders, car unloaders, trucks and such things should not only be used so as to reduce the cost or work, but by using such things work can progress with a minimum number of men.

New York Restores Broken Highways While Maintaining Traffic.

By FRANK W. BRISTOW, Superintendent of Maintenance, New York State Highway Commission.

“MAIN Street” in any hustling community will serve to illustrate the relative importance of route 6 in the system of State-county-town highways in the State of New York.

Beginning at Buffalo, the foot of navigation of the Great Lakes, this route traverses the State from west to east, paralleling the New York Central and the West Shore Railroads and also the Barge Canal for a distance of 300 miles to Albany at the head of navigation of the Hudson River, where it joins two through north and south routes paralleling the same railroads and the Hudson River for a distance of 150 miles to New York City.

It has been estimated that of New York State's 10,000,000 population, 90 per cent are included in a belt 10 miles wide paralleling the New York Central Railroad, so that clearly route 6 and its southerly prolongation is the main artery connecting the

centers of population to which the balance of the complex network of improved highways are but tributaries.

It is a “highway of military and national economic value” as defined by the United States Highways Council.

This route is improved throughout, usually with broken stone bituminous macadam about 16 feet wide and about 6 inches thick, the foundation soil being generally clay, and the topography varying from gently rolling to very flat.

This road has been and is still being extensively used by the military authorities of the Federal Government in transporting fleets of Army motor trucks frequently loaded to a gross load of 8 tons, of which two-thirds of the load is concentrated on the rear axle, which fleets vary from 30 units to nearly 100 in number, and are sent across the State several times a week.

About the 1st of April of this year the headquarters office of this department was, without any preliminary warning, suddenly bombarded by a torrent of complaints from automobile and municipal officials and also of our own engineers located along the western 100 miles of this route, between Buffalo and Auburn.

EMERGENCY MEASURES REQUIRED.

The substance of these complaints was that the bottom had dropped out of long stretches of this important road and that numerous long sections were impassable to traffic.

Prompt instructions were given to the maintenance men throughout the sections involved to proceed immediately with such temporary repairs as would at least make the road passable. At the same time careful inspections were made to determine the location and extent of the broken sections, and it was found that the total length of road requiring reconstruction was approximately 40 miles, composed of numerous short sections, of which about 25 miles were segregated in the western 100-mile length extending between Buffalo, Rochester, and Auburn. An emergency appropriation of \$1,000,000 was quickly passed by the legislature to provide funds for these repairs, plans were made, and proposals invited for restoring a considerable portion of these broken sections with concrete pavement, to be 18 feet wide and 7 inches thick, our investigations having led to the conclusion that the failure was due to foundational weakness and also because the roads were called upon to bear a destructive load at the time when the frost was coming out of the ground.

While the thin macadam crust might have bridged over the unstable foundation soil for occasional heavy loads, in our opinion the truck traffic with the numerous separate units following each other at regular short intervals caused the macadam to weave, thereby puddling or pumping the moisture to the immediate subgrade and so decreasing its stability to the extent that the macadam crust soon broke through under the concentrated wheel loads, resulting in churning together a mixture of soft mud and broken stone fragments to a considerable depth, rendering the affected section practically impassable.

These conditions were promptly temporarily remedied by smothering the areas affected by any materials immediately available which would give increased stability, as broken stone, gravel, or even ashes and similar refuse, at the same time forming lateral drains whenever possible to expedite drying out these mud holes.

HIGH-COST CONCRETE CONSTRUCTION.

Of the proposals received for concrete reconstruction one project providing for building $3\frac{1}{2}$ miles, composed of several sections of various lengths within a distance of more than 7 miles, was awarded at a cost approximating \$33,000 per mile, the mixture to be 1 part cement, $1\frac{1}{2}$ parts sand, and 3 parts broken stone, all materials being purchased by the State subject to contractor's shipping directions, so as to assure priority shipment privileges.

The proposals submitted in connection with the other projects at this time were deemed exorbitant,

being greatly in excess of our estimates, and they were accordingly rejected as on that basis the funds authorized evidently would not cover the work necessary, so that a change in the proposed type of reconstruction became advisable.

Proposals were again invited upon six projects averaging 3 miles length of construction, each consisting of numerous sections of new work varying from 300 feet in length to about 1 mile in length and providing for leveling off and consolidating the existing broken road, forming new earth shoulders, laying a heavy foundation course of crushed furnace slag 6 inches compacted thickness, upon which was to be laid a broken stone bituminous macadam surface, penetration method, 2 inches rolled thickness, the surface to be 16 feet in width, the binder generally being refined tar applied at the rate of $1\frac{1}{2}$ gallons per square yard in two applications, the top stone having been partly filled with stone chips before the first application, with the result that the six projects aggregating more than 18 miles were awarded to five distinct contractors at an average cost of \$21,000 per mile, the requirement in each of these contracts being that the work be carried on in such a manner as to allow traffic the use of one-half the width of the road at all times, a pay item being inserted in each contract for maintaining traffic.

Tar binder was selected because at the time of preparing the plans the assurance of its delivery was more certain than for asphalt. Slag for foundation was selected because it is cheaper than stone.

HOW THE WORK WAS CARRIED ON.

These contracts were promptly started and progressed at the rate of about 1 mile completed work per month, with a minimum interference with traffic so that the pavements were practically completed by the middle of September.

The concrete was laid, one-half the width at a time, the middle joint having a triangular key way moulded into the section first laid, this being intended to so tie the two halves together that in the event of movement under frost action or otherwise, the two halves would move together and uniformly. In the case of the new macadam work where the width of the right of way permitted, a side road was provided, but where the width or topography would not permit of this, the stone was delivered in piles on one side of the road, the bottom course being kept filled and rolled as near to the end of the spread as practicable, generally about 100 or 200 feet. In finishing the top course, the usual practice was to pour half width at a time, when one side was completed turn traffic upon same, and proceed with the other half.

In some cases, however, the plan was adopted of closing off traffic for a period of 30 minutes, during which time a section of top course would be completed, then opening the road to allow the accumulation of vehicles to pass, requiring say about 10 minutes, again closing, and repeating the same operation.

By reason of the tar binder being somewhat slow in setting, particularly in warm weather, the effect of permitting traffic upon the freshly poured surface has been to produce a final surface that perhaps is not as smooth as could be desired.

All unloading of carloads of stone, slag, sand, etc., was performed by elevators into bins and practically

all materials were hauled from bins at railroad delivery points to the roads by motor trucks. The application of binder was by mechanical pressure distributors. Grading was done as much as possible by scrapers, and the entire construction program executed so far as feasible by other than hand labor, labor being both scarce and inefficient, and demanding wages of from 40 to 50 cents per hour.

RESURFACING BY DEPARTMENT FORCES.

In addition to the seven contract projects before enumerated, an aggregate of 18 miles composed of various short sections, usually in distant portions of this main through route, were resurfaced or reconstructed with bituminous macadam, using departmental equipment and forces in our direct employ, this work varying from 3 to 7 inches or more in thickness, depending upon the necessity for foundational reinforcement, the same also being laid one-half width at a time or if full width by temporary closing to traffic or by providing a side road, so as to interfere with traffic as little as practicable.

It may be of interest that the above direct departmental work included over 2 miles where the repairs were made by utilizing the labor of convicts from Auburn State Prison, supervised by our foreman.

This gang of prisoners, averaging twenty in number, were transported every working day from the prison accompanied by a guard, to and from their work, a distance not exceeding 8 miles each way, in a 5-ton motor truck. This department furnished a commissary camp and these men were given two hot meals daily on the job; for their services this department paid to the prison department \$1 per day for each man, including the two or three men at the mess camp. This payment included both transportation and the meals referred to. The service of this gang compared favorably with force labor.

Soon after the completion of the macadam, the bituminous surface in several instances appeared rather bare and open after being subjected to traffic for a brief time, and it was deemed prudent to seal it by a light surface treatment of cold application tar applied at the rate of one-quarter gallon per square yard with either sand or screenings for cover.

HOW TRAFFIC WAS KEPT GOING.

The traffic during the past summer season has been above the normal. In addition to the military truck traffic, there was the usual touring and commercial traffic, together with an enormous volume of traffic due to new pleasure and commercial motor vehicles being delivered by being driven across the State under their own power.

While a passable way was maintained for traffic throughout the work under construction, it was of necessity in places but a single track way, involving leaving at intervals of not more than a quarter of a mile either gaps in delivery of construction materials or in some instances especially graded wider spots to permit opposing traffic to pass. Existing farm driveways also served well as turnouts. Warning signs to run slow and also conspicuous signs marking passing places were found necessary.

Also through the agency of touring information bureaus, traffic was encouraged to follow detours which diverted an appreciable amount of traffic around instead of over the work in progress.

Costs of this work were more than double those prevailing on similar construction prior to our advent into the world war, but urgent necessity is the justification for paying such prices.

We would have preferred our new construction to have been continuous within a contract limit instead of being broken into several shorter sections, but in harmony with the spirit of the time we endeavored to conserve transportation, labor and materials and only restore sections which were actually broken.

Of the million dollar appropriation previously referred to, the Commissioner allotted \$50,000 which, as far as necessary, will be expended in keeping certain main routes which have been selected by representatives of the War Department open during the coming winter. The length so selected is between 500 and 600 miles of improved highways.

While the precise details for handling this work are not fully decided, it is expected to take advantage of the experience of neighboring States which have previously encountered similar problems.

How Ohio Handled Important Roads Broken Down by Huge Traffic.

By CLINTON COWEN, State Highway Commissioner.

WITH a bright, cheerful day, the thermometer at a guess standing at about 60° in the shade, with many varieties of fall flowers yet unaffected by the frost, I am forcibly reminded of the contrast of weather conditions of one year ago. On November 22, 1917, I reported at Toledo with the chief engineer of this Department to meet Mr. Osterman, Field Secretary of the Lincoln Highway Association, Captain Butchers and Mr. E. W. James of the Bureau of Public Roads, to accompany them across the State to search out the best possible route for Government truck service passing

through the northern part of the State to Pennsylvania. The day was unseasonably cold and blustery, with a substantial fall of snow for the time of year. The ground was frozen. Altogether, the prospect of making a journey across the State was one of severe business unalloyed with any pleasure that the condition of weather might afford.

Mr. James asked me very pointedly what I proposed to do with a certain class of roads that seemed certain to him would yield under continuous heavy traffic of Government trucks that were then about to start from Detroit to the East. The thought

of Mr. James seemed to be that during soft and wet weather the severe strain to which our roads would be subjected would cause many to break up and disintegrate. This, indeed, did happen, but not until the approach of spring, nor was it confined to any particular type of road. It was rather due to the character of construction that was not intended for the unusual test of heavy trucks passing rapidly in succession, each following closely in the track of the preceding truck.

SNOWS MAKE UNUSUAL CONDITIONS.

But long before our sorrows commenced with road failures we were early confronted with unusual conditions. Beginning with November 22, the ground was scarcely exposed for a day until the final break up in the spring. Snow storm after snow storm, adding its might to the original with the unusually cold weather that prevailed and continued almost up until March made highway travel in the northern part of Ohio on many roads quite impossible. This brought about a condition unlooked for and one which the State was utterly unprepared to combat because of lack of equipment to take care of such a condition and because the obligation of taking care of it seemed to rest with township authorities.

Realizing that the Government needs were imperative and that truck trains must move, we carried into effect the request of the National Council of Defense to provide a means for Government transportation. Much credit for our success was due to the county surveyors and the township trustees through which the road runs. None of the county surveyors and but few of the township



WAR-TIME DESTRUCTION OF OHIO ROADS. TOP—TAR MACADAM ROAD NEAR SANDUSKY, BROKEN DOWN BY HEAVY TRUCKING OVER A WEAK FOUNDATION. BOTTOM—BRICK ROAD IN SUMMIT COUNTY, DESTROYED BY HEAVY TRUCKS AND REPAIRED WITH 8-INCH CONCRETE FOUNDATION, MONOLITHIC TYPE.

authorities neglected to use their best efforts in complying with our request. It would have been practically impossible for the State to have handled the work single handed, as the law had not made provision for such conditions.

With the congested condition of the railroads and their inability to promptly handle supplies that were needed in almost every community, it became necessary after opening up main arteries for travel to open up the lateral roads in order to reach the possible outlet to and from markets and villages. The amount of traffic these highways must sustain is apparent. The truck traffic was practically constant with all additional vehicles conceivable using many of the roads.

TRAFFIC DESTROYS HIGHWAYS.

Not only did the truck and automobile traffic greatly increase, but burdens were placed upon them

clearly in excess of what any ordinary road would be expected to carry. This great increase in traffic was, of necessity, confined largely to such roads as had been prepared by the removal of snow drifts, etc.

While the unusual depth of snow, due to the long, cold weather, caused much inconvenience by obstructing our highways, we had the advantage of the frozen condition of the roadbed which was sometimes rough but nevertheless passable. However, when the spring came the greatly increased loads and amount of traffic that had become accustomed to follow certain roads, together with the softening of the frozen ground to the very bottom, caused many of our main highways to break down under this heavy strain. Roads that had carried normal to heavy traffic for years were wrecked in a few days.

The problem of placing these roads in condition for use and to maintain them for traffic until the weather came on which would permit the destroyed roads to be rebuilt was no small one. In some places car loads of material were dumped on the road merely as a temporary means of carrying traffic until a more favorable time came to detour the traffic and rebuild the road. Finally the good weather of summer came on and the heavy through traffic which had concentrated on a few of the main highways was scattered or diverted over the secondary and earth roads to give us an opportunity to rebuild the main roads destroyed in the spring.

REPAIRING THE IMPORTANT ROADS.

To accomplish all this work meant no little anxiety and trouble on the part of our road officials. The project must be financed, the labor problem

met and the shipping conditions of the materials had to be given individual study in order to obtain what was desired and accomplish results.

The most important routes which required our attention in Ohio were the Government truck route leading across the northern part of the State from Toledo to East Palestine and the National Road between Columbus and Wheeling. The latter I would especially mention. Labor was scarce and inferior and the cost, as all know, was two or three times the amount paid during normal times. On account of these abnormal conditions and the great demand for the improvement of this road, it was felt that legal technicalities should not prevent the carrying out of a project that seemed necessary to promote Federal assistance in transporting army trucks and materials from the west. Accordingly, we brushed aside legal technicalities that might be considered of importance in normal conditions, and proceeded to build 14 miles of brick road in Muskingum County by force account contract. The estimated cost of this work was \$488,500. The final cost will possibly exceed the estimate by about 20 per cent. This is already accounted for in the increase in freight rates and the amount of material that would be used in a force account job in excess of one under contract. The work was completed in about 180 days. Our success was largely due to the use of convict labor. We found it efficient and it no doubt had a stabilizing effect on all other labor connected with the work. In addition to this brick road, we also completed this season more than 10 miles of macadam road on the National Road in Guernsey County. This was also done by force account and largely by the use of prison labor.

Rhode Island Replaces Sections Wearing Out with Better Type of Roads.

By A. L. ATWOOD, Chairman State Board of Public Roads.

RHODE ISLAND'S expenditures for State road and bridge work during 1918 will be approximately \$600,000, of which \$500,000 will be for roads and \$100,000 for bridges. Our available road fund is made up of approximately \$275,000 secured from motor vehicle registrations and approximately \$225,000 from a State highway tax of 3 cents per \$100 upon the ratable property of all towns and cities in the State. The road funds from both sources are available only for maintenance and reconstruction.

The State highway system of Rhode Island is made up of 325 miles of road, of which 208 miles are of plain or waterbound macadam and 117 miles are bituminous macadam or bituminous concrete.

The maintenance of our plain macadam roads has been a serious problem for a number of years. Many of these roads were built from 10 to 15 years ago according to the provisions of our original State highway law, which restricted the width of metalled surface to 14 feet. These roads also were frequently paid for from appropriations which were too meager to allow of proper foundations and drainage structures or to allow of desirable grades and alignment. Many of these old macadams, furthermore, are located upon our main trunk lines and are called upon now to carry a mixed traffic of from 250,000 to 800,000 vehicles annually. The reconstruction of wornout macadams was taken up in Rhode Island at a later date than was the case in the majority of

States which began State road building at an early date and constructed in consequence a great deal of plain macadam. The financing of reconstruction work also since it was commenced has not been sufficiently liberal to permit carrying out the work as rapidly as would have been desirable.

The conditions surrounding the building and reconstructing of our plain macadams as described previously have brought about a serious condition as far as the maintenance of these roads is concerned. The unusual conditions now surrounding all construction work are naturally particularly serious in their effect upon the maintenance of our old wornout macadams.

OLD MACADAMS RE-CONSTRUCTED.

During the past spring when frost action upon our roads

was at its maximum, there were a number of sections of old waterbound macadam which were next to impassable for heavy vehicles and which were difficult even for light touring cars to negotiate. In view of the importance just at that time of our main highways in relieving a serious congestion of railroad freight, these prohibitive sections of highway were deplorable. It was manifestly impossible with the funds at our disposal to reconstruct according to modern standards all of the bad sections of plain macadam, but we have succeeded in relieving conditions very materially by reconstructing with proper foundations and relatively permanent surfaces many of the sections which were practically prohibitive to travel during winter and spring thaws. We have also placed foundations upon a number of bad sections and have placed over these foundations a temporary surface of gravel or of plain macadam until such time as our funds and more propitious conditions make practicable the laying of more

durable wearing surface. We have taken care of still other prohibitive sections by drainage projects only.

Our plain macadams have as a consequence of our work during the past season been lessened in mileage as a result of reconstruction and have been brought upon the whole to much better condition to carry travel during the coming winter than was the case one year ago. To be sure, we still have sections which are far from good, but these sections are fewer than they were.

BITUMINOUS ROADS HOLD UP WELL.

The maintenance of our bituminous macadam roads and of our bituminous concrete roads has been a comparatively simple task. The roads of this type came through the winter in fully as good condition as has been the case in past years in spite of the great increase in certain localities of motor-truck travel because of the unusual military, naval, and



TRAFFIC DEMANDS ON OHIO ROADS. TOP—TRUCK TRAIN AT WOODVILLE, WINTER OF 1917-18. BOTTOM—24-TON STEAM SHOVEL MOVING OVER A MONTGOMERY COUNTY HIGHWAY.

industrial activity, and because of conditions surrounding the movement of rail freights. These roads are now in very good condition and perfectly capable of carrying the travel to which they will be subjected during the coming winter.

Our heavier work of reconstruction has, of course, been handicapped more or less by the unusual conditions prevailing. We have, however, been able to carry all of this work along without serious delay and without the necessity for stopping any of it. By far the greater number of jobs started will be completed and those not completed will have progressed so far that completion will be a simple matter next season and so that travel can without serious inconvenience pass over the work during the winter months.

In carrying out maintenance work we made an earnest and successful endeavor to reduce our normal use of bituminous materials in accordance with the request of Federal authorities. The usual quantity of bitumens used by this department annually for maintenance work is about 700,000 gallons. In 1918 the quantity used for maintenance has been approximately 200,000 gallons. Many of our plain macadam roads had a considerable accumulation of bitumen upon their surfaces from a number of applications in past years. Roads in this condition were not treated this year, as is our usual custom, and we are able so far to see no serious result from the omission. It appears, however, that treatment of these roads next year will be imperative in order to avoid serious deterioration. It will, however, be possible, if the demand for reduction in use of bitumen still exists, to omit next year the treatment of some of the roads treated during the past year, and it will of course be unnecessary to treat the plain macadams which were reconstructed this year.

STEAM IN PLACE OF MAN POWER.

The trying conditions surrounding construction work during the past year have brought about some changes in our methods of doing work and have necessitated the greatest care in the planning of our work. Steam shovels, for instance, were used for excavation work so uniformly shallow that under normal conditions we would consider hand-work only. The use of steam shovels was also further extended than is customary to the handling of materials from storage piles in order to save labor. Much handwork and team hire was also avoided by the employment of scrapers hauled by trucks or light steam rollers.

Our State highway law does not permit us to remove snow and ice in order to keep our road open during the winter months. All work of this nature, under the terms of our law, is done by town or city road authorities. The snow problem is not nearly

as serious in Rhode Island as it is in States farther inland. Ordinarily we experience few falls of snow which render our roads impassable for long periods, even though no work of opening the roads is done.

Existing conditions made necessary a considerable change during the past year in our method of laying out our work. Labor shortage made necessary a very careful study of labor conditions immediately before work of any sort was actually started. The desire to have our main trunk lines passable at all points during the entire year caused us to spread out our work more than has been our custom and in many cases to adopt temporary surfaces over foundations placed to take care of soft places. Our policy of carrying out our work did not include the enhancing at the earliest possible moment of the comfort of high speed travel. The repair of sections of road which were simply inclined to be rather rough at high speeds gave way under our plan of work to the repair of sections which at times were so soft that travel over them was virtually impossible.

We did not attempt to make plans for work extending over long periods. Conditions were changing rapidly throughout the construction season. New Federal restrictions were imposed from time to time, the supply of available labor fluctuated, and railroad freight embargoes were frequent. In laying out our work therefore we adopted a policy which during normal times might well be termed a "hand-to-mouth" method of doing work. Nothing was started until it seemed probable that it could be completed or at least carried to such a stage that travel could pass over the site of the work during the winter and early spring.

Now that the construction season is over and a retrospective view of our work is possible we are agreeably surprised to note that the numerous difficulties which were apparent early in the season were not as insurmountable as they then appeared. It seems to us that under conditions as they are we must go slowly in planning our work and that no project should be started until a careful study has been made in order to ascertain its necessity and also to determine the probability of carrying it to a successful conclusion.

It is not our belief that road work should be stopped. Our good roads should be maintained from the standpoint of economy and our very bad roads, especially those sections upon important main through trunk lines, should be made serviceable for the traffic which is so necessary to our industries at this time. We feel that road improvement is of greater importance now than it ever has been before, but we perceive also the necessity for looking at the road problem from the standpoint of military and industrial necessity.

Costs Shown Under Washington's State Highway Maintenance Law.

By GEORGE F. COTTERILL, Chief Engineer, State Highway Department.

DURING the six years preceding 1917 the Washington program of "Good roads" had resulted in about 1,250 miles of construction along the primary State highway routes, of which 330 miles had been improved by the counties under the permanent highway law. The counties had also constructed more than 400 miles of permanent highways on secondary State highways and other main lines of travel. Without definite figures it is a safe estimate that at least an additional 350 miles of main county highways had been improved of like character with permanent highways from the proceeds of county bond issues, road and bridge funds, district funds and by assessment district procedure.

Thus, there was by 1917 a total of about 2,000 miles of constructed primary State highways, permanent highways, and other roads of like character, representing an investment of at least \$15,000,000 by the State, counties, and districts during the six years preceding. This progressive program was authorized for continuance of construction during 1917 and 1918, assuring the further investment of at least \$5,000,000 and the addition of about 500 miles to the list. This will make altogether about 1,500 miles of constructed primary State highways and about 1,000 miles of other main county lines of travel improved to permanent highway standards of construction by the end of 1918, or a total of 2,500 miles of improved main highways, outside the cities, throughout the State.

MAINTENANCE LAW OF 1917.

The legislature of 1917 was confronted by a situation in which the accumulated 800 miles of constructed primary State highways were under obligation of maintenance by the State Highway Department from a construction percentage fund yielding only \$75,000 annually, while the counties were provided with a construction percentage fund of \$75,000 plus an apportionment of surplus motor-vehicle revenue yielding \$225,000 and increasing annually, or at least a \$300,000 annual total with which to maintain about 1,200 miles of permanent highways and other county roads of like character. It was apparent that the provision for the primary State highways was grossly inadequate, while that for the county permanent highways and other roads of like character had proved ample. Facing the alternative of doubling the maintenance percentage from the public-highway fund for application to primary State highways, the legislature

squarely placed this maintenance as a first claim upon the funds derived from the motor-vehicle surplus revenue, working out the 1917 law with the following basic features, viz:

(1) All highway maintenance to be under direct county administration, with State Highway Department regulative control and reserve power to enforce standards of maintenance on constructed primary State highways.

LARGE SUM MADE AVAILABLE.

(2) Abolition of former $7\frac{1}{2}$ per cent of public-highway fund for maintenance, releasing it for construction program; increase of motor-vehicle fee schedule by about 50 per cent, so as to produce a surplus over license administration expense, estimated to realize \$425,000 in 1917 and \$675,000 in 1918, for apportionment to county permanent highway maintenance funds in addition to the 5 per cent of permanent highway levy, or \$75,000 annually. (This had the net effect of providing \$500,000 for 1917 and \$750,000 for 1918 to support the increasing maintenance program, as compared to \$375,000 in 1916, \$200,000 in 1915 and much smaller amounts in preceding years.)

(3) This ample maintenance provision is made applicable for expenditure by the county authorities only for the maintenance and repair of (a) constructed primary State highways; (b) permanent highways (i. e. highways constructed under the permanent highway law); and (c) other highways of like character (i. e., highways along main lines of travel improved by counties from any fund to construction standards equal to requirements of permanent highway law); also (d) for equipment for the maintenance of the preceding classes of highways.

(4) The expenditure of these county permanent highway maintenance funds is safeguarded by requirement that county auditors shall only issue warrants on vouchers approved by the engineer in charge and allowed by the board of county commissioners for the sole purpose of maintaining and repairing the highways of the described classes and their maintenance equipment.

CAN USE CONSTRUCTION FUND.

(5) In the event that there is not sufficient money to the credit of the permanent highway maintenance fund in any county to maintain the constructed primary State highways within the county, the county commissioners shall expend any necessary amount of the county credit of permanent highway (construction) fund to accomplish such maintenance, and if this be not sufficient or available they shall pay the remainder from the general road and bridge fund of the county. By these provisions the 1917 law squarely lays down the principle that the constructed primary State highways must be adequately maintained even at the expense of a construction fund. Maintenance of the roads we have stands ahead of new construction.

STATE OF WASHINGTON—MAINTENANCE AND REPAIRS—PRIMARY STATE HIGHWAYS.
Expenditures June, 1917-May, 1918 (inclusive); compiled from County Engineers' Reports to State Highway Commissioner.
SEGREGATED BY COUNTIES.

County.	Period, June-December, 1917.			Period, January-May, 1918.			Combined year.		Special notes.
	Mileage.	Expenditure.	Per mile.	Mileage.	Expenditure.	Per mile.	Expenditure.	Per mile.	
Adams.....	25.28	\$422.63	\$16.72	25.28	\$489.38	\$19.36	\$902.01	\$36.08	Natural earth grade; light traffic.
Asotin.....	25.10	570.00	22.71	22.65	72.65	3.21	642.65	283.10	Includes \$7,000, washout repairs.
Benton.....	34.67	2,779.98	80.18	44.67	12,471.74	279.20	15,251.72	359.38	
Chelan.....	7.00	100.00	14.29	15.13	1,502.50	99.30	1,602.50	113.59	Includes \$2,500, auto equipment.
Chittenden.....	76.24	5,674.12	74.55	76.74	14,792.50	192.76	20,466.62	267.31	Includes resurfacing north section.
Clarke.....	16.04	4,426.09	275.00	18.04	6,323.81	350.55	7,749.93	429.60	Includes extensive resurfacing.
Columbia.....	18.90	5,742.82	303.81	23.46	5,097.91	217.30	10,840.73	557.11	Includes \$5,700, auto equipment.
Cowlitz.....	19.48	5,845.87	300.09	23.14	9,959.17	430.39	15,805.04	730.48	Includes \$1,000, equipment.
Douglas.....	20.07	480.00	23.92	27.52	2,360.21	85.76	2,840.21	108.68	Only nominal maintenance.
Franklin.....	None reported			1.91	15.93	8.34	15.93	8.34	Includes extensive resurfacing, equipment, etc.
Garfield.....	5.78	1,161.56	200.96	5.78	4,517.24	781.53	5,678.80	982.49	
Grant.....	20.44	1,253.00	61.30	21.03	1,736.92	82.59	2,989.92	143.89	Includes extensive resurfacing.
Greys Harbor.....	68.27	27,218.56	398.69	72.25	14,319.74	198.19	41,538.30	566.88	
Jefferson.....	31.84	4,773.28	149.91	31.84	2,794.32	87.76	7,567.60	237.67	
Kearney.....	119.68	59,709.16	498.91	119.68	51,373.60	429.25	111,082.76	928.16	Includes extensive repairs, equipment, etc.
Klickitat.....	65.15	9,356.41	143.61	90.90	7,214.71	79.37	16,571.12	219.68	Includes snow removal, sprinkling, etc.
Lewis.....	77.90	2,673.34	34.32	77.90	9,580.39	122.99	12,253.73	157.31	Includes \$4,000, south approach to Cowlitz Bridge.
Linn.....	39.45	10,206.20	258.71	39.45	3,784.99	95.94	13,991.19	354.65	Includes extensive resurfacing.
Mason.....	46.50	3,689.42	79.35	46.50	3,988.92	85.78	7,678.34	165.13	
McClellan.....	24.03	1,475.61	59.91	55.65	4,440.10	79.79	5,915.71	139.70	
Pacific.....	78.66	3,680.06	47.14	86.24	9,803.21	113.67	13,483.27	160.81	Includes new decking Skagit Bridge.
Pierce.....	27.00	7,880.68	291.88	27.00	6,596.67	244.32	14,477.35	536.20	Includes \$2,000, flood repairs, Silviana Bridge.
Skagit.....	42.41	6,943.25	163.71	42.41	3,001.38	70.77	9,944.63	234.48	
Snohomish.....	93.63	9,642.61	102.99	95.88	6,610.63	68.94	16,253.24	171.93	
Spokane.....	8.91	300.00	33.67	8.91	1,166.72	130.95	1,466.72	164.62	
Stevens.....	45.63	2,501.91	55.03	56.53	6,245.20	110.48	8,756.11	165.51	Includes \$1,500, equipment.
Thurston.....	38.09	10,385.81	272.66	44.00	2,108.39	47.92	12,494.20	320.58	Includes \$4,800, auto equipment.
Walla Walla.....	8.07	407.40	50.48	21.06	1,870.39	112.55	2,777.79	163.03	
Whatcom.....	63.53	13,683.03	215.38	63.53	14,824.62	233.99	28,507.65	442.37	Includes \$16,000, equipment.
Whitman.....	118.85	10,838.09	91.36	118.85	9,794.77	82.41	20,632.86	173.77	
Yakima.....	1,243.77	210,829.89	169.50	1,385.33	219,338.74	158.34	430,168.63	327.84	
State.....									

SEGREGATED BY TYPES OF PAVEMENT OR SURFACING.

Period.	(1) Brick pavement.	(2) Concrete pavement.	(3) Sheet asphalt.	(4) Asphaltic concrete.	(5) Bituthitic (warrentie).	(6) Bituminous macadam.	(7) W-B macad- am (cr. rock).	(8) Gravel surfacing.	(9) Natural earth grade.	(10) Bridges and trestles.	Total, all types.
JUNE-DECEMBER, 1917.											
Counties.....	1	10	2	2	3	6	14	24	4	3	29
Road sections.....	3	20	3	6	4	13	40	108	12	4	213
Mileage.....	8.81	90.59	5.97	19.74	14.41	40.21	159.90	792.40	109.74	2.00	1,243.77
Expenditure.....	\$9,456.51	\$5,092.45	\$326.03	\$319.76	\$2,978.50	\$5,493.49	\$25,353.79	\$143,311.52	\$11,043.37	\$8,474.37	\$210,829.89
Expenditure per mile.....	\$1,073.38	\$57.21	\$54.61	\$16.19	\$206.70	\$136.62	\$158.43	\$180.85	\$100.63	\$3,737.23	\$169.50
JANUARY-MAY, 1918.											
Counties.....	1	12	2	2	4	6	14	27	5	7	30
Road sections.....	3	24	3	8	5	13	45	115	20	10	246
Mileage.....	8.81	102.41	5.97	23.24	17.81	40.21	174.74	\$39.96	168.54	3.70	1,385.33
Expenditure.....	\$3,352.32	\$2,809.97	\$36.52	\$225.52	\$3,748.29	\$4,833.66	\$29,536.06	\$149,379.28	\$8,434.02	\$17,003.10	\$219,338.14
Expenditure per mile.....	\$380.51	\$27.44	\$6.12	\$9.70	\$210.45	\$120.21	\$169.63	\$177.55	\$50.04	\$4,595.40	\$158.34
COMBINED YEAR.											
Counties.....	12	22	4	4	7	12	28	51	9	10	103
Road sections.....	36	60	9	18	19	39	109	345	60	30	603
Mileage.....	105.63	1,002.82	17.94	62.98	52.22	160.42	534.64	2,391.60	308.28	6.70	2,612.16
Expenditure.....	\$12,808.83	\$7,902.42	\$382.55	\$45.28	\$6,726.79	\$10,327.15	\$54,809.85	\$282,090.80	\$19,477.39	\$24,477.37	\$430,188.63
Expenditure per mile.....	\$453.89	\$33.65	\$60.73	\$25.89	\$127.51	\$256.83	\$327.46	\$588.70	\$150.67	\$3,332.63	\$227.54

(6) In the event of a demonstrated surplus in the permanent highway maintenance fund of any county, over and above adequate provision for its prior highway maintenance obligations, such surplus is applicable only to "the maintenance or improvement of roads upon the route of primary State highways."

FIRST YEAR'S RESULTS EXCELLENT.

The law has now been in operation for more than a year and we are in a position to review and compare some of its results. The first and most outstanding fact is that the law of 1917 has provided adequate funds and fixed administrative authority and control whereby the 2,000 miles and more of constructed primary State highways, county permanent highways, and other roads of like character, are for the first time in the history of the State of Washington and its counties, being maintained on a planned, continuing system, instead of the traditional method of the "Arkansas Traveler." These main State and county roads of Washington have been maintained through one season and to the middle of a second season under a traffic averaging at least a third more than before 1917, and in many localities abnormally increased in volume and tonnage by war-time traffic development, and they are standing the test, measurably meeting even these emergency demands beyond the capacity of their construction types. Despite the combination of most expensive and difficult conditions affecting maintenance labor, materials, and transportation, and the wear upon the roads under unprecedented traffic demands, the law of 1917 has provided the funds and the organization to meet the situation. In the face of a situation which, unprovided for, would have brought break-down and destruction to hundreds of miles of our new road system, I believe it can fairly be said that the main highway system of Washington was never in better shape, under constant and substantial upkeep, than now in this midseason of 1918.

There are submitted herewith two tabular statements showing from a financial standpoint the operation of the 1917 maintenance law as applied to the constructed mileage of primary State highways for the combined year covering the period from June, 1917, to May, 1918, inclusive. The first table shows the expenditures segregated by counties, covering (1) the seven months period from June to December, 1917; (2) the five months period from January to May, 1918; and (3) the combined 12 months. The detail figures show the mileage reported on by each county, the total maintenance expenditures reported, and the average expenditure per mile in each county, for the respective periods and for the combined year. The second table shows the expenditures segregated by types of pavement or surfacing, distributed into the same two periods and for the combined year, with total expenditures,

mileage, and rates per mile for each type of construction. The number of counties reporting and the number of road sections reported upon will also be found in this table, and are most necessary for basing any attempts at analytical comparisons between types.

THE MILEAGE MAINTENANCE COST.

It is interesting to note that during the seven months closing 1917 there was a total expenditure of \$210,829.89 reported upon 1,243.77 miles of constructed primary highway, and during the opening five months of 1918 an additional sum of \$219,358.74 upon 1,385.33 miles, or a total of \$430,188.63 expended during the combined year. This does not include expenditures in a few counties on improvements under the surplus provisions of the act. It takes no account of the cost of maintaining approximately 800 to 900 miles of county permanent highways and other roads of like character not on primary highway routes, which have been maintained from the county maintenance funds under the act of 1917, but of which no reports are required to be made to State authority.

It would seem reasonable to consider that the combination of these two fractional periods will include expenditures rather more than are to be expected within a calendar year. In 1917, due to the new maintenance law not becoming effective until June 7, there was a holding off of the large spring maintenance work until after that date. In 1918, with the system under full headway, the large maintenance costs came during March, April, and May, which last year were piled up in June.

This circumstance, combined with the war-time costs of all maintenance, labor, and materials has produced the mileage average expenditure of \$327.84 for the combined 12 months' period covering from June, 1917, to May, 1918, inclusive. It would seem a safe estimate that \$275 per mile should cover a calendar year period, and under normal price conditions this may be brought down to \$200 per mile.

There are 30 counties with sections of constructed primary State highways under maintenance, and it will be noted that the county mileage averages of expenditures vary between the abnormal extremes of \$8.34 and \$982.49 per mile for the year which happen to adjoin in the alphabetical list of counties, and there are all shades of variance between these extremes. These arise from unusual repairs or incidental improvements, equipment purchase apportionments, more or less resurfacing of gravel and macadam sections, all listed in these figures of maintenance and repairs and averaged over the mileage in varying degrees in the different counties. There are also expected variances between counties which must result from the varying volume of traffic and consequent wear and necessary upkeep of their sections of primary highway.

COST OF VARIOUS ROAD TYPES.

The statement of expenditures segregated by types of payment or surfacing presents an interesting field for comparative study in certain general features, even though its period is too short for any detail comparisons between pavement types. It must not be overlooked that these figures include all expenditures upon the entire highway, its roadbed, drainage, slopes, etc., as well as its surfacing or pavement. The first five classifications include what are commonly referred to as "hard-surface pavements." Recognizing that the figures for (1) brick and (5) bitulithic, etc., are largely made up of distributed costs of repairs amounting to reconstruction of short sections, and are not normal maintenance charges, it can be broadly stated that the annual upkeep cost of the approximately 150 miles of primary highway covered with hard surface pavement is from \$50 to \$100 per mile. In sharp contrast, the next three classifications, including the various types of oil and water-bound macadam, crushed rock and gravel surfacing, covering nearly 1,100 miles of the primary system, are costing from \$250 to \$350 per mile for their upkeep. Here is a distinct gap of \$200 to \$300 per mile of annual maintenance cost between the "hard-surface pavement" group and the "macadam-gravel" group of our primary State highways.

But plainly this contrast does not fully measure the gap, because the 150 miles of hard-surface pavements cover highway sections carrying double or treble the traffic as compared to the macadam-gravel mileage. A study of the latter by counties shows that it has varied from \$75 to \$900 per mile of annual maintenance cost, the variances being almost directly responsive to the traffic demands. It seems a safe conclusion that if the hard-surface pavements mileage had been of the macadam or gravel type, if it could have been maintained at all under its present traffic on such surfacing, the annual cost would have averaged more than \$600 per mile. It is certain that at least \$500 per mile, or the equivalent of 5 per cent interest on a \$10,000 investment per mile is being saved in direct maintenance cost wherever a properly-built hard-surface pavement has replaced macadam or gravel on a heavy traffic section of highway.

THREE PUBLIC ROADS MEN GAVE LIVES IN WORLD'S STRUGGLE FOR DEMOCRACY.

The Bureau of Public Roads has three gold stars on its service flag for former members of its force who lost their lives in the Army. Two of them were killed in action in France. The third was a victim of the influenza epidemic, while in training at Camp Meade. The total number of bureau representatives in the service was 49.

Capt. Willis E. Comfort.

The first bureau man to lose his life while serving in France was Capt. Willis E. Comfort, who was killed near Soissons, July 18, last. Capt. Comfort, whose home was in Kansas and who was a graduate of the Kansas Agricultural College, class of 1914, entered the service of the bureau in June, 1915, as a student engineer in the drainage division. When the Mexican troubles broke out in the spring of 1916 he enlisted as a private in the District of Colum-

bia National Guard and soon after went with his company to the Mexican border. Later that year he took the examination for second lieutenant in the Army, and on receiving his commission resigned from the bureau December 31, 1916.

He was a member of the first expedition sent to France in 1917, and as a lieutenant had command of a squad in the action in which the first three Americans to be killed in France fell. He was at a listening post when a German bombardment started. He was knocked unconscious by a shell bursting near him, but soon recovered and made his way back to his men. Later during the heaviest shelling he distinguished himself by making his way to a telephone station and back. He was mentioned in the reports of this action for heroic work in attempting to rescue a soldier caught under french debris, and for his conduct was promoted to captain.

At the time he was killed he was serving with Company F, Sixteenth Infantry. After being severely wounded in the fighting he refused to be evacuated to the rear, but led his company until he fell mortally wounded.

Lieut. Percy A. Rideout.

Lieut. Percy Adams Rideout, junior engineer in the Bureau of Public Roads until he left to enter the Army July 1, 1917, was killed in action on the Verdun front, France, October 8 and was buried October 10 in the officers' cemetery at Froidos, France. His own platoon formed the funeral escort and firing party. Lieut. Rideout originally enlisted as a private in the One hundred and first United States Engineers. He was a sergeant when he went overseas September 25, 1917. Later he was promoted successively to second and first lieutenant, being transferred to the First United States Gas Regiment (Thirtieth Engineers), volunteering for this dangerous and difficult service.

Lieut. Rideout was born in Ashburnham, Mass., but his boyhood was spent in Concord, that State. He graduated from the Massachusetts Institute of Technology in 1911, and was for a year connected with the engineering corps of the Cleveland, Cincinnati, Chicago & St. Louis Railway. He entered the Bureau of Public Roads July 1, 1912, as engineer student, and a year later was made junior engineer. He was married; his widow, Mrs. Helen Palmer Rideout, now living in Braintree, Mass.

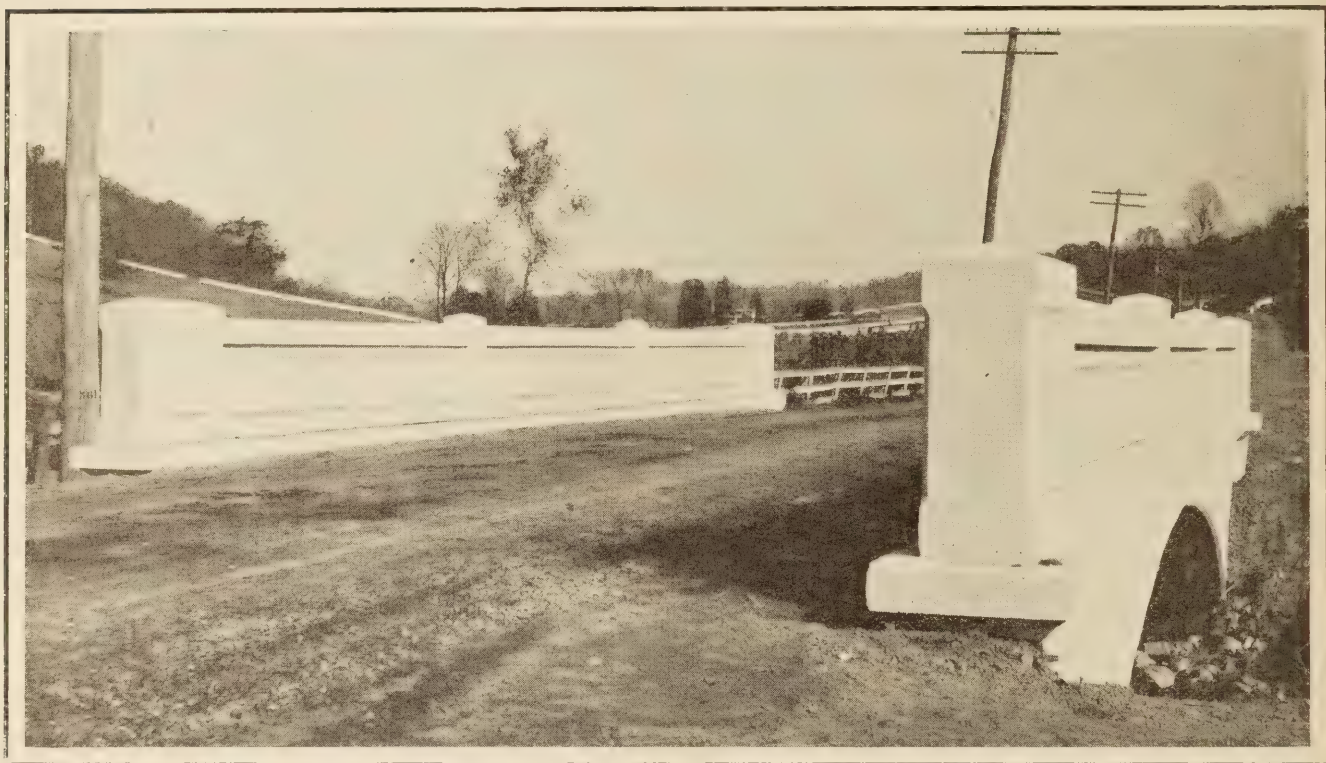
While with the bureau Lieut. Rideout was an efficient, trusted, and highly esteemed member of its force. The personnel of the bureau on November 8 adopted resolutions testifying to its respect for and appreciation of his character and his services, both in the bureau and in the Army.

William Brown.

Pvt. William Brown died at Camp Meade, Md., in October after an influenza attack. Mr. Brown was an Indianian and had been with the Department of Agriculture for several years. In 1917 he was transferred from the Office of Experiment Stations to the Bureau of Public Roads, and something over a year ago was made auditor of the Portland, Oreg., district office. He had registered for the draft in the District of Columbia before going there and was called for service in June, 1918. He was a member of the Eighth Company, Second Battalion, One hundred and fifty-fourth Depot Brigade.

BRIDGES MUST BE SAFE FOR MODERN HIGHWAY TRAFFIC

By J. L. HARRISON, Bureau of Public Roads.



A MARYLAND STATE HIGHWAY COMMISSION BRIDGE DESIGN.

NO chain is stronger than its weakest link. Neither is any road stronger than its weakest bridge. It is, therefore, important that every highway official give careful consideration to the strength of every bridge structure which he erects, for it should be obvious that every bridge should be able to support any load which is permitted on the highway of which it is a part. Not only should it be able to support these loads when it is erected, but it should be so designed that even the heaviest loads which may come onto it will be carried without danger to the structure, and so that it may continue to perform its proper functions over a considerable period of time.

The current practice among experienced engineers is to make all highway bridges strong enough to carry the weight of the bridge itself and a load of from 12 to 15 tons at a factor of safety of from 4 to 6. In other words modern highway bridges are usually designed to carry from 50 to 75 tons of moving load. Of course no modern highway loads weigh anything like this amount, but it has been found in practice that this is advisable because of unavoidable defects in the materials used, errors and defects in construction, mistakes in design, and losses in

strength due to the deterioration of the materials used, etc., all of which must be very carefully guarded against if serious accidents are to be avoided.

WHY WOODEN BRIDGES BREAK DOWN.

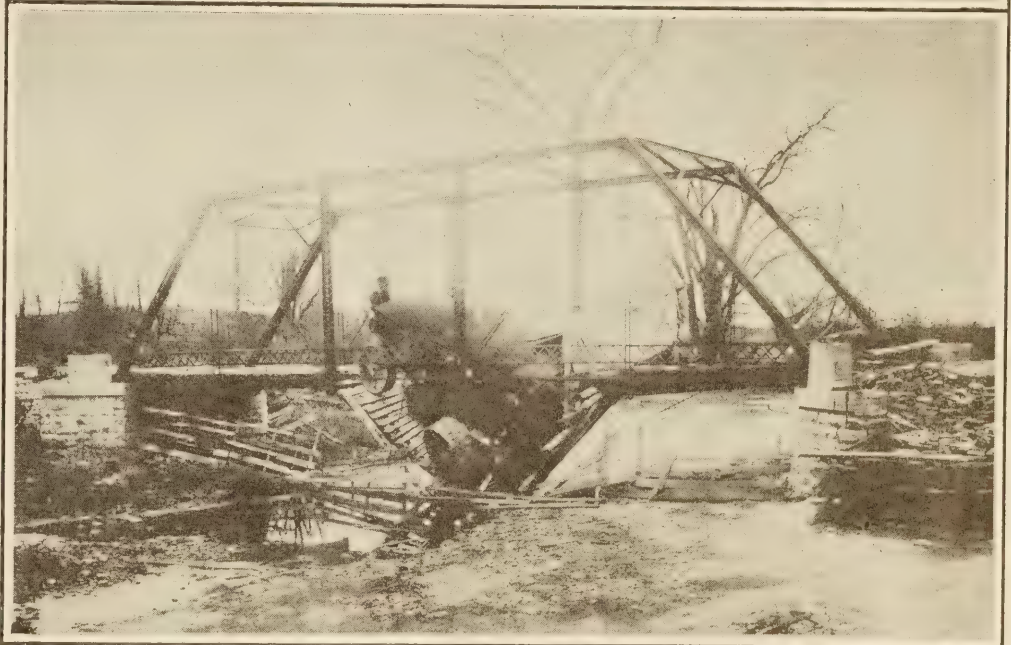
Wooden bridges are the source of more accidents than all other types of bridges combined. This is due to the fact that local officials who would not attempt to design a steel bridge or a concrete bridge will often turn over the design of important wooden structures to local firms of contractors and builders who, though excellent construction men, know little or nothing of the actual strength of the timber bridges which they erect. Many of these structures are strong enough to carry light loads, such as farm wagons and ordinary automobiles, but they are frequently too light for heavy trucks, traction engines, and similar heavy loads. But the traction engine and the heavy truck are legitimate and recognized traffic units and should, therefore, be provided for as carefully as the more common vehicles.

To avoid the construction of dangerous wooden bridges the proposed design should always be submitted to and approved by the State highway

department or some competent bridge engineer. If this is done both the construction of bridges which are too light and the construction of those in which material is wasted will be avoided.

REGULAR INSPECTION IMPORTANT.

A still more important matter is the regular inspection of timber structures, and for that matter of all forms of bridges, to see that decay or the disintegration of the materials used has not rendered the structure dangerous. As a matter of fact, there are probably more accidents caused by the failure of responsible highway officials to inspect bridges under their care and remove rotten timbers, tighten loose joints in trusses, and otherwise keep up the structures which have been placed in their care, than can be charged to any other single cause. This is not a very creditable condition of affairs, and when it is realized that loss of life and property, due to the failure of such structures, is a common occurrence—so common, in fact, that hardly a county in the United States is without numerous examples of it—the seriousness of the situation is even more disagreeable to contemplate. The jurisdiction of most highway officials is of limited extent. Many local highway officials have only a few square miles to cover and within this area there are never many structures. Most local officials could, therefore, make a careful inspection of every structure within their jurisdiction in from one to two days. This should be done at least twice every year and it would be better to do it every three months. When decayed timbers are

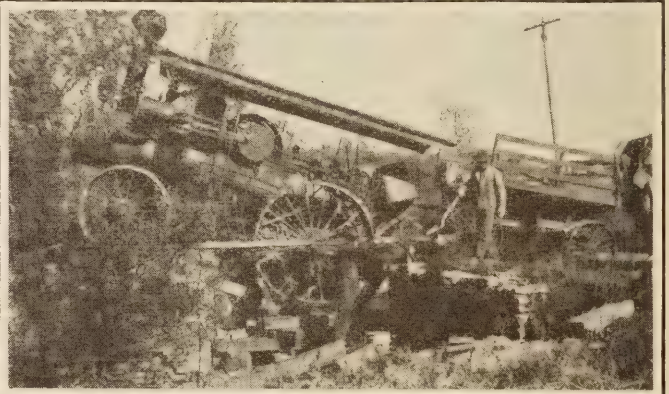
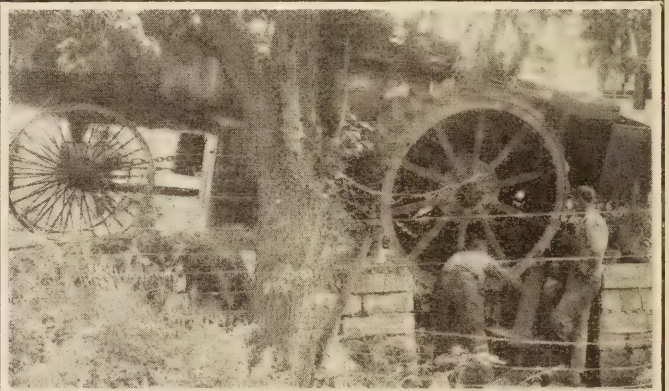


TOP—STEEL BRIDGE DESIGNED BY A HIGHWAY COMMISSION. TYPICAL LOW TRUSS SPAN IN IOWA, SUPPORTED ON CONCRETE ABUTMENTS AND DESIGNED TO CARRY 15-TON TRACTION LOAD. BOTTOM—STEEL BRIDGE DESIGNED BY BRIDGE (?) COMPANY TO MEET LOCAL DEMAND.

found they should be marked and promptly removed. If joints have opened, or if bolts are loose, they should be tightened at once. If structures are unsafe for heavy loads, signs so stating should be erected in such a manner that everyone using the structure may be adequately warned, and as soon as it is possible to do so the structure should be replaced by one which will safely carry modern heavy highway loads.

APPROVED DESIGNS NECESSARY.

Steel bridges are too often let to the lowest bidder without regard to what sort of a design he submits. As with wooden structures, plans should



TOP, LEFT—BRIDGE BUILT ON UNASSISTED LOCAL DESIGN. RIGHT—EVEN THIS COULD BE IMPROVED BY PROPER MAINTENANCE. CENTER, LEFT—UNSAFE BRIDGE WITH NO WARNING SIGN. RIGHT—HOW MUCH HAS THIS ACCIDENT COST THE OWNER OF THE TRACTOR? BOTTOM, LEFT—NO WARNING SIGN ON THIS DANGEROUS BRIDGE. RIGHT—PRIMITIVE FORM OF CONSTRUCTION CAUSES TROUBLE.

be prepared and specifications drawn before bids are asked for, and in this way the excessively light steel spans now so common in many localities will be avoided. In short, all bridge designs, steel, concrete, stone, and timber, should be prepared by competent bridge engineers. The State Highway Departments will usually give assistance in preparing these plans, or competent local engineers may be employed; but in every case bridge plans

and specifications should be prepared by men who have special knowledge of this subject, and their erection should be in the hands of competent and experienced men. If this course is followed, and if then local officials will give close personal attention to the regular inspection and repair of the bridges placed in their care, the thousands of bridge accidents which now result in a large annual loss of life and property can be very largely avoided.

PROTECTION FROM SNOW.

The New York State Highway Commission will spend \$20,000 in the construction of fences to keep snow from drifting into roads. The 900 towns of the State are expected to provide machines to remove snow.

INDIANA HIGHWAY BULLETIN.

The State Highway Department of Indiana has begun the publication of a monthly bulletin showing the activities of the department. The first number appeared early in October.

WORK OF THE BUREAU OF PUBLIC ROADS FOR THE LAST FISCAL YEAR.

THE Director of the Bureau of Public Roads has submitted to the Secretary of Agriculture his annual report for the fiscal year ended June 30 last. Up to that time 52, or 28 per cent, of the 187 male employees on the rolls of the bureau April 6, 1917, the date of our entrance into the war, had enlisted for military service. On September 30 the number had been increased to 72, or 38.5 per cent. In addition to these men in the military service, 18 engineers had been assigned to Army posts and cantonments to supervise and inspect highway construction. An engineer was assigned to the United States Shipping Board and one to the United States Housing Corporation of the Department of Labor to assist in working out highway and street problems in connection with housing projects.

WORK FOR MILITARY PURPOSES.

Much of the time of the engineer of tests was devoted during the year to the assistance of the Emergency Fleet Corporation in testing materials for and in the design of concrete ships. The testing laboratory was engaged to a considerable extent in the design of apparatus for the Ordnance Bureau for testing the power of explosives. Complete and detailed maps covering coast counties of a considerable part of the Atlantic seaboard region and detailed maps of the Army truck route from Detroit to Baltimore were made for Army use, the latter in cooperation with the Geological Survey and the Corps of Engineers. The principal highways in a zone extending from Boston to Newport News were plotted on topographic sheets for the use of the Geological Survey in the preparation of aeroplane maps.

Cooperation was given the Capital Issues Committee in connection with highway, irrigation, and drainage bonds. During the year inspections were made of 126 highway projects, involving bond issues aggregating \$49,276,366, 25 irrigation projects involving \$18,279,060, and 30 drainage projects involving \$19,356,970, or a total of 181 projects involving bond issues of \$86,356,396.

THE HIGHWAYS COUNCIL.

Early in 1918 an arrangement was entered into with the Fuel Administration by which that organization would issue permits for bituminous materials for highway work upon recommendation of the bureau. This work was merged in June, 1918, into the work of the United States Highway Council, which held its first meeting on June 8. It had become apparent early in the year that some method

of coordinating the various powers of the Government with reference to highways was necessary, not only to the proper regulation of highway work during the war but to enable really essential highway work to be done. On request of the Secretary of Agriculture, the Secretary of War, the Director General of Railroads, the chairman of the War Industries Board and the Fuel Administrator named representatives to serve with the Director of the Bureau of Public Roads in forming the Highways Council to control highway construction in the country during the period of the war. The Director and the chief of management of the bureau serve, respectively, as chairman and secretary of the council. It has done an immense amount of work since its organization in considering highway projects submitted.

Up to June 30 under the arrangement with the Fuel Administration and under the Highways Council, 2,235 applications had been received, calling for the equivalent of 75,000,000 gallons of bituminous materials, of which 58,000,000 gallons had been approved and permits issued.

FEDERAL AID ROAD ACT.

Work under the Federal aid road act progressed well during the year. Efforts were made, in cooperation with the several State highway departments, to restrict construction work to such projects as would prove of greatest importance, serve the greatest economic or military use, and contribute to the Government's war program.

During the fiscal year legislative assent required by section 1 of the act was given by the legislatures of all the States for which such assent had not already been given except Alabama. The legislature of that State meets only quadrennially, and its next session will not be held until January, 1919, when the assent is expected. In the meantime the governor has assented for Alabama, as authorized by the act.

During the year proposed standard plans, specifications, proposal notice, contract and bond forms submitted by 34 States were reviewed. Where changes in the forms were thought desirable suggestions for the changes were made to the respective State highway departments. Proposed forms of specifications, notice to contractors, contract and bond were prepared jointly by the Bureau and the Forest Service and reviewed by the solicitor of the department, for use in connection with forest road construction. With a view to greater uniformity in the forms of specifications, notice to contractors, contract and bond used by the several State high-

way departments, a proposed standard form was prepared and submitted for general adoption by the States, subject to such modifications as might be necessary to adapt them to statutes and particular requirements of the respective States.

RULINGS ON AGREEMENTS.

It was determined that when a project agreement is entered into between the Secretary of Agriculture and a State highway department such agreement constitutes an expenditure of the Federal funds thereby set aside and allotted to the project; and also that a project statement might be submitted and approved and the project agreement entered into prior to the beginning of the fiscal year out of which the apportionment for which Federal payments would be made, but that construction work could not commence prior to beginning of the fiscal year.

It was also determined that any balances that may occur in connection with projects covered by project agreements will accrue to the funds available to the State for the fiscal year within which such balances occur. It was decided that it is unnecessary to specify any particular fiscal year's apportionment from which the Federal funds allotted to a project should be payable, the purpose being to consider disbursements of the Federal funds in the aggregate instead of by fiscal years.

Project statements were submitted by all the 48 States and plans, specifications and estimates by 46 States. At the end of the fiscal year construction work was in progress in 30 States, work had been completed and final payments made on 5 projects, having an aggregate mileage of 17,643, costing \$347,380.70, and on which \$166,274.84 Federal aid was paid. The total amount of Federal aid paid out for construction during the year was \$425,445.85.

FEDERAL AID OF \$16,049,821 INVOLVED.

During the year a total of 563 projects were passed upon by the department, of which 559 were approved and 4 rejected. Project agreements were entered into to cover 205 of these 559 projects and also for 13 projects approved prior to the beginning of the fiscal year. These 218 agreements involved an estimated cost of \$14,239,939.15 and Federal aid of \$5,658,458.42. The project statements approved and not covered by agreements involved an estimated cost of \$28,038,831.23 and \$10,391,363.32 Federal aid. All the projects for which the statements were approved and into which agreements were entered have an aggregate mileage of 6,249.39, and involve Federal aid to the amount of \$16,049,821.74 out of an estimated cost of \$42,278,770.38.

At the beginning of the year a working plan for 1918 was prepared in cooperation with the Forest

Service for the work on National forest roads. As the season advanced unfavorable conditions made it necessary to eliminate several projects until after the war. During the year preliminary investigations were made on 62 projects, reconnaissance surveys on 47 and locations surveys and plans on 41, a total of 150 projects, having a total mileage of 3,233.75. Construction was under way on about 53.5 miles of road in 10 National forests, estimated to cost \$366,411.

OBJECT-LESSON ROADS.

Considerable work was done by the division of road building and maintenance investigation. Object-lesson roads were built of sand-clay construction in North Carolina, top-soil construction in Virginia and gravel construction in Texas, superintendence of the construction of county roads was conducted in Virginia, and work completed on an experimental post road in Iowa. Reports were made on county road systems for counties in Texas and California, several State highway departments were assisted in various lines of work and advice given in regard to special road problems in many States. Designs for bridges were prepared for a dozen projects in various States, and general designs and specifications which had been prepared by several State highway departments and local officials were examined and reviewed.

The economic highway survey, inaugurated toward the end of the preceding fiscal year, was continued. The complete maps and text give detailed information on the roads, bridges and economic conditions in the territory covered by the surveys. The work has proven of greater value than was at first anticipated, as it brings together in a workable manner much detailed highway information. It has been of value to State highway departments and to the work of the Bureau, and has proven valuable to other branches of the Government. Copies of the completed maps are supplied to the Post Office Department, Geological Survey and to the War Department.

HIGHWAY WORK IN THE STATES.

During the year a thorough investigation was completed as to the organization, personnel, powers and duties of State and local highway forces, the classification of highways, the procedure followed in their construction and maintenance, and of the method of raising and handling funds for road purposes. The results of this study are now being published.

Current data in regard to State highway mileage and expenditures and as to automobile registrations and the disposition of these revenues were collected. In the calendar year 1917 expenditures on our rural roads amounted to \$279,915,332. Of this

total \$98,179,332, consisting of \$47,290,790 State and \$50,888,542 local funds, were expended under the supervision of the several State highway departments. A total of 4,983,340 motor cars, including commercial vehicles, and 257,522 motor cycles were registered in the 48 States and the District of Columbia. There was collected in registration and license fees \$37,501,237, of which \$23,235,898 or about 67 per cent, were expended more or less directly under the control of the State highway departments. This sum was about 49 per cent of all the State funds devoted to rural roads and bridges.

ROAD TESTS AND MATERIAL DIVISION.

The loss of employees and inability to replace them with experienced men, the cooperation with other branches of the Government in war activities and supervision of material specifications and tests for Federal aid work, and assistance to the Fuel Administration in connection with the work of the United States Highways Council cut down the research work of the Road Tests and Material Division materially, as compared with the preceding year. The work of the Conference of State Highway Testing Engineers and Chemists, held during the year 1917, was supplemented by the preparation of two bulletins. In general the recommendations of the conference were followed, with a view to standardizing specification requirements of all types of road materials.

Twelve hundred and eighty-nine samples were examined in the chemical laboratory, a decrease of 3 per cent over the preceding year. The physical laboratory tested 1,009 samples, an increase of 10 per cent, while the 630 samples of road-building materials examined and classified by the microscopic laboratory showed a decrease of 7 per cent.

As a result of research and experimental work, as well as observation of the work of highway engineers throughout the country, a set of typical specifications for bituminous materials for various types of

roads and methods of use were prepared and sent to all manufacturers interested, with the request that they review the specifications and suggest changes they thought desirable, giving reasons for such changes. Upon receipt of all the information that could be secured these specifications were redrafted and published as Department Bulletin 691, "Typical Specifications for Bituminous Road Materials." This bulletin contains 30 specifications for petroleum, asphalt, and tar products, with descriptions of the general methods of use for which the materials are suitable, methods of testing the materials for conformity with the specifications and directions for sampling. An investigation of the relation of the consistency of road oils at normal temperature to the so-called asphalt content test has been completed.

QUARRY INVESTIGATIONS.

During the year an exhaustive investigation of commercial quarry practice in the production of crushed stone for road-building purposes was begun. A special study was made of such practices in the New England and Middle Atlantic States. A progress report, "The Commercial Sizes of Broken Stone Aggregate," has been published, and a report has also been prepared on small scale production, dealing in an elementary manner with the selection of quarry sites and the installation and operation of equipment. The survey of quarry conditions in the United States has been continued in the West and South, and so far about 170 quarries have been studied.

Subjects under investigation at the end of the year included the suitability of various types of soil for the construction of bituminous soil roads, the standardization of screening practice in the production of crushed stone, and the use of slag in road construction.

Cooperative work with the American Society for Testing Materials was continued, and as a result a number of standard methods and definitions were recommended to the society for adoption.

ROADS AS MEMORIALS.

A suggestion is advanced in the Minneapolis Tribune as to memorials for those who sacrificed their lives for liberty. The idea is that there are better things with which to memorialize the dead than stone monuments and mausoleums, and particularly appropriate would be works of public utility in memory of those who lost their lives in the war and whose bodies received burial on the field of battle. The suggestion is that the money which would be expended on shafts and statues be used for road building, the road to bear the name and probably some other means of identification, so as to constitute a memorial to the dead.

PRISON LABOR IN NEW JERSEY.

The New Jersey State Highway Commission has made an arrangement with the department of corrections and charities for the use of inmates of the reformatory at Rahway by the contractor of section 1 of State Highway route No. 1 in Metuchen. The contractor was unable to secure sufficient labor to complete the pavement before cold weather set in, and this reformatory labor was resorted to in the emergency. Commissioner Clark states that this labor is proving both economical and highly efficient. It is thought that more and more labor of this sort will be used in the State under similar conditions.

STRETCH OF BRICK ROAD IMPORTANT NEBRASKA FEDERAL AID PROJECT

By E. H. MOREY, Assistant State Engineer.

DURING the past three months (August-October) Nebraska has had 200 miles of Federal aid roads under contract. The most important of these is a stretch of $5\frac{1}{2}$ miles, 3-inch vertical fiber brick pavement on a 5-inch concrete base, constructed between Lincoln and Emerald, in Lancaster County. This road embodying the essential qualities necessary for modern commercial transportation will receive at its completion a large share of interstate traffic, as it is a portion of the O. L. D. Highway on the direct route from Omaha, Nebr., to Denver, Colo.

The original earth road consisted of humus and clay. In about two-thirds of the mileage the road was of a clay base with a light surface of humus. The remaining one-third was of pure clay. Drainage was very poor. The road situated as it was in the center of an agricultural district proved worthless for traffic in certain seasons of the year. During the heavy spring and fall rains, the clay hills, being of a gumbo quality, worked up easily and as a result deep chuckholes and ruts were so frequent that it was finally decided nothing short of hard surfacing could withstand the traffic.

Accordingly contract for plans was undertaken by the county through Federal aid, under direction of the State board of irrigation, highways, and drainage. The construction company awarded the contract began work April 24 with about 80 laborers. There was one woman on the job who drove a team.

The line of the Lincoln-Emerald road runs on a section line and is comparatively straight. The problem of drainage made a complete drainage survey necessary.

GIVEN WELL-DRAINED FOUNDATION.

The original road furnished excellent data, and careful consideration on the part of the engineer in charge has resulted in a well-drained foundation.

The road is 22 feet wide for the first mile where it adjoins Lincoln, and 18 feet wide the remainder of the $5\frac{1}{2}$ miles. It has 10-foot earth shoulders, 2-foot ditches made with a 1-to-1 slope. The crown is 4 inches. Concrete for the base is prepared in a three-fourths yard steam propelled mixer, with a carrier discharge. Specifications called for a 1-3-5 mixture. Considerable difficulty was experienced in the setting of the concrete on the second mile of roadway. However, this was caused by a period of dry weather and hot winds. A heavy rain set the concrete in first-class condition, and it was ready for the sand cushion. The sand was loaded from a local

sand pit and hauled a distance of 2 miles to the work, where it was spread to a thickness of 2 inches.

One of the labor-saving devices used was the brick carrier. It consists of a long trough with wooden rollers on which the bricks were carried from the pile to the layer. It required two men to load the bricks and one to lay them. An average of 33 bricks to the yard and approximately 700 yards were laid per day. About 50 carloads of brick laid 1 mile. The vertical fiber bricks were freighted from Galesburg, Ill.

A filler of asphalt and residium oil was applied after the bricks had been carefully rolled, and sand sprinkled over it.

THE LABOR SITUATION NOT SERIOUS.

The labor question is not as yet serious in the road construction problem in Nebraska. Three and one-half to four and one-half dollars per day is paid to the ordinary workman. This work is inspected by representatives from the Federal Government, State and county. The State appropriated \$35,000 and the Federal Government \$35,000, the remainder being paid by the abutting property owners.

The construction now is 75 per cent finished. When complete, $5\frac{1}{2}$ miles of one of the best roads in the State of Nebraska will be opened to all kinds of traffic. A military training school is within 1 mile of the new road. Dairy and poultry, as well as agricultural farms, adjoin the entire route. With the establishment of the "Return Load Bureau," this portion of the roadway will afford a "marketing highway" of vast importance.

The subject of good roads has stimulated widespread interest in every county throughout the entire State. Nebraska farmers especially are pushing the improvement of present roads with feverish haste. Nebraska people are awakening to the possibilities of what good roads mean, and are unwilling to be outdone in this movement by any other State in the Union.

AUGUST AND SEPTEMBER FEDERAL AID.

In August the number of Federal aid projects which went to final agreement exceeded those approved, the numbers being 46 and 30, a total of 76 projects on which action was taken. The total cost of these 76 projects is estimated to be \$6,391,269.47 and the Federal aid allowance \$2,326,683.61. The

aggregate road mileage of all projects is 733.965. Twenty bridges are included in the projects.

Georgia led in the number of projects considered. Nine in that State were approved and three others went to final agreement. The former, including 17 bridges and aggregating 63.1 miles of sand-clay, top-soil, and other roads, are estimated to cost \$413,811, with an allowance of \$180,658.96, and the latter for 26.29 miles of road and one bridge will cost \$217,656.18, with an allowance of \$100,000. The total estimated cost of the Georgia projects is \$631,469.18 and the Federal aid \$280,658.96.

Texas and Michigan each had 6 projects considered. One Texas project, for 3.275 miles of bituminous gravel road, was approved, and final agreements were signed for five, with an aggregate mileage of 58.769, estimated to cost \$308,357.63 and an allowance of \$142,077.70. Final agreements were signed for all the six Michigan projects. They involved 2.884 miles of brick or concrete and 27.513 miles of gravel road, at an estimated cost of \$453,829.40, with Federal allowance to the amount of \$203,816.19.

The largest expenditures proposed are for two Kansas roads,



CONSTRUCTION OF A FEDERAL AID BRICK ROAD IN NEBRASKA. TOP—LAYING CONCRETE BASE. CENTER—SPREADING SAND CUSHION. BOTTOM—LAYING THE BRICK.

39.70 miles of concrete, estimated to cost \$1,172,-797.53. Final agreements were signed for both projects, with an allowance of \$175,919.64. The largest allowance during the month to a single State was \$284,040 for two Maine roads, aggregating 28.45 miles of bituminous macadam, and which are estimated to cost \$667,171.20. Two Ohio projects, one 11.92 miles of brick or concrete the other 7.45 miles of brick, are estimated to cost \$580,700. The allowance made in the agreements is \$146,119.50.

Minnesota led in the total mileage of projects. Four from that State for gravel roads, for which final agreements were signed, aggregated 104.62 miles. The estimated cost is \$321,676.81 and the Federal allowance \$105,000.

In September 39 Federal aid projects were approved and final agreement for 9 were signed. The mileage of all the projects was 427.939 and the estimated cost \$3,906,672.65, while the allowance amounts to \$1,383,481.44.

Maryland projects involve the greatest cost and will receive the largest Federal aid allowance. Two concrete roads in that State aggregating 70 miles are estimated to cost \$720,000, with an allowance of \$360,000.

Final agreement executed for a single project in Delaware was for 5.72 miles of brick road, estimated to cost \$639,349. Only \$5,000 a mile Federal aid was requested and allowed for the project, the total allowance being \$28,550.

A single project in Ohio approved is for 8.09 miles of brick road to cost \$390,000, for which the allowance is \$80,000. Georgia led in the number of projects considered in September as in August. The 6 projects approved and the one for which final agreement was signed aggregate 42.44 miles, estimated to cost \$332,324.29, with an allowance of \$140,591.04. Alabama had 5 projects approved, for 24.056 miles of gravel and sand-clay roads.

FEDERAL AID PROJECTS IN AUGUST, 1918.

State.	Project No.	County.	Length in miles.	Type of construction.	Project statement approved.	Project agreement executed.	Estimated cost.	Federal aid allowed.
Alabama	32	Conceh.	6.01	Sand-clay	Aug. 6		\$36,001.95	\$18,000.97
	34	Montgomery	.24	Bridge	do.		49,225.00	17,000.00
Arizona	6	Apache	13.00	Gravel	Aug. 10		130,020.00	65,010.00
Georgia	4	Oconee and Walton	10.782	Topsoil		Aug. 26	50,269.44	20,000.00
	5	Alma, Nichols, Bacon	17.71	Sand-clay		do.	46,411.33	20,000.00
	7	Macon	0.89	Sand-clay, 2 bridges		Aug. 13	120,975.41	60,000.00
	8	Montgomery and Wheeler	0.60	Bridge	Aug. 28		90,008.87	42,500.00
	9	Rabun	8.00	Graded and drained earth	do.		46,728.00	20,000.00
	10	Towns	9.00	do.	do.		44,027.50	16,158.96
	15	Coweta	4.00	Topsoil or sand-clay	do.		18,843.00	7,000.00
	16	Meriwether	12.40	do.	do.		42,053.00	14,000.00
	17	Harris	19.00	Earth surfaced with topsoil in part	do.		42,944.00	21,000.00
	26	Bulloch		7 bridges	Aug. 13		43,246.50	20,000.00
	29	Emanuel		8 bridges	do.		54,961.50	25,000.00
	36	Douglas	12.10	Topsoil	Aug. 28		31,047.50	15,000.00
Illinois	5	Marshall	21.60	Concrete and earth	Aug. 21		280,680.00	90,000.00
Iowa	21	Jackson	16.30	Earth	Aug. 6		60,280.00	25,090.00
Kansas	13	Leavenworth	22.00	Concrete	Aug. 21		548,963.51	82,344.54
	15	Reno	17.70		Aug. 26		623,834.02	93,575.10
Maine	1	Brunswick	15.57	Bituminous macadam		Aug. 14	337,789.31	155,700.00
	3	Kennebec	12.88	do.		Aug. 26	329,381.91	128,340.00
Michigan	9	Washtenaw	2.884	Concrete or brick		Aug. 28	86,708.99	28,840.00
	10	Arenac	6.883	Gravel		Aug. 13	88,170.49	44,085.24
	11	Alpena	5.525	do.		Aug. 1	48,265.69	24,132.84
	13	Livingston	6.52	do.		Aug. 13	104,939.25	43,885.62
	14	Barry	4.333	do.		do.	84,659.44	42,329.72
	15	Livingston	4.232	do.		do.	41,085.54	20,542.77
Minnesota	14	Carver	26.49	do.		do.	50,146.66	20,000.00
	20	Goodhue	21.25	do.		Aug. 28	133,486.34	35,000.00
	32	Lyon	27.78	do.		do.	58,545.43	25,000.00
	33	Murray	29.10	do.		do.	79,498.38	25,000.00
Mississippi	33	Tunica	4.03	Clay gravel	Aug. 10		25,245.00	12,500.00
	34	Madison	6.00	Gravel	Aug. 6		28,792.00	14,000.00
Missouri	8	Harrison	9.60	Concrete and macadam	Aug. 28		141,669.00	70,834.50
	11	Callaway	7.60	Gravel	Aug. 14		42,759.64	21,379.82
	12	Cole and C'sage		Bridge	Aug. 2		105,050.00	52,525.00
Nebraska	17	Lancaster	9.99	Graded earth		Aug. 26	40,155.00	20,077.50
	19	do.	4.00	Earth	Aug. 22		15,840.00	7,920.00
Nevada	2	Nye	14.75	Gravel		Aug. 30	44,120.45	22,060.22
New Hampshire	14	Coos	0.95	Bituminous macadam		Aug. 13	15,052.24	7,526.12
North Carolina	4	Craven	9.46	Topsoil and sand-clay		Aug. 28	21,089.23	10,000.00
	9	Polk	13.02	Gravel	Aug. 13		30,717.35	14,000.00
	31	Buncombe	2.60	Concrete	do.		77,442.20	20,000.00
North Dakota	1	Cass	16.33	Graded earth		Aug. 16	15,015.13	7,527.56
	2	Foster	15.00	Gravel and earth		Aug. 13	16,257.32	8,128.66
	7	Stutsman	9.20	Earth		Aug. 29	19,424.98	9,712.49
	11	Stark	18.96	do.		Aug. 12	29,720.22	14,860.11
	20	Wells	16.80	Graded earth		Aug. 13	22,512.73	11,256.36
	21	Boonville	17.70	do.		Aug. 12	23,584.38	11,792.19
	23	Ransom	25.50	Earth	Aug. 28		41,272.00	20,636.00
	32	Cass		2 bridges	Aug. 22		19,954.00	9,977.00
Ohio	11	Ashtabula	11.92	Brick or concrete		Aug. 26	141,000.00	119,000.00
	18	Highland	7.43	Brick		do.	139,700.00	27,119.50
Oklahoma	3	Oklahoma	2.04	Brick, concrete, asphalt or pitch		Aug. 16	46,172.80	20,400.00
	4	Comanche	2.70	Concrete		Aug. 2	53,600.00	26,800.00
	5	Bryan	11.64	do.		Aug. 29	223,679.59	111,839.79
Oregon	5	Union	9.55	Earth		Aug. 22	41,151.00	20,575.50
	8	do.	6.01	do.		do.	30,000.00	15,000.00
South Carolina	11	Baker	4.15	Graded and drained earth	Aug. 7		22,498.00	11,249.00
Tennessee	1	Richland	2.12	Concrete		Aug. 1	51,679.11	24,352.60
	5	Greene	2.64	Water bound macadam	Aug. 6		38,321.91	19,160.95

FEDERAL AID PROJECTS IN AUGUST, 1918--Continued.

State.	Project No.	County.	Length in miles.	Type of construction.	Project statement approved.	Project agreement executed.	Estimated cost.	Federal aid allowed.
Texas	2	Brooks	20.10	Sand-clay or gravel		Aug. 26	\$41,725.52	\$20,000.00
	21	Gregg	14.49	Bituminous macadam		do.	57,970.97	19,000.00
	31	Bexar	18.182	Bituminous gravel		Aug. 30	110,168.74	55,084.37
	33	Harris	4.157	Gravel shell base, bituminous surface		do.	33,399.36	15,397.81
	49	Nolan	11.84	Sand, clay, and gravel		Aug. 29	65,191.04	32,595.52
	73	Gaudalupe	3.275	Bituminous gravel		Aug. 21	12,156.68	5,000.00
Virginia	9	Chesterfield	3.07	Concrete		Aug. 13	69,017.39	30,600.00
	11	Lee	2.16	Waterbound Macadam		Aug. 12	42,100.00	21,050.00
	16	Botetourt and Rockbridge	5.398	do.		Aug. 6	49,384.28	24,692.14
Washington	12	Thurston	3.526	Concrete		Aug. 14	87,964.50	35,000.00
West Virginia	14	Mingo	4.00	Earth		Aug. 13	54,700.00	8,075.00
	19	Ohio	.568	Concrete		Aug. 14	11,435.25	5,680.00
Wisconsin	4	Shawano	7.34	Gravel		Aug. 26	35,710.59	11,903.53
	9	Kewaunee	1.50	Gravel macadam		do.	8,994.48	2,998.16
	34	Iowa	8.17	Earth		do.	20,569.95	6,856.65
	37	Portage	5.98	Gravel		do.	23,897.48	7,965.83
Total			733.965				6,391,269.17	2,328,683.61

Revised agreement, original executed August 27, 1917.

RECORD OF FEDERAL AID PROJECTS IN SEPTEMBER, 1918.

Alabama	31	Lamar	6.14	Gravel	Sept. 28		\$21,240.50	\$10,620.25
	33	Dale	2.72	Sand-clay	do.		16,093.00	8,046.50
	35	Pike	6.00	do.	Sept. 9		15,587.00	7,793.50
	36	Covington	2.00	do.	do.		15,807.00	7,903.50
	37	Jackson	7.196	do.	do.		33,964.92	16,982.46
Arkansas	20	Poinsett	8.84	Gravel	Sept. 12		61,029.10	30,000.00
Delaware	1	Newcastle	5.72	Brick	Sept. 12	Sept. 12	639,349.59	28,550.00
Florida	6		5.59	Sand-clay	Sept. 18		20,228.84	10,114.00
Georgia	3	Brooks and Lowndes	6.64	do.	Sept. 5	Sept. 5	61,965.39	30,000.00
	19	Bleckley	7.80	Earth	Sept. 18		30,008.00	15,000.00
	28	Paulding	9.15	Sand-clay or gravel	Sept. 9		30,767.00	15,000.00
	33	Troup	5.95	Sand-clay	Sept. 28		44,434.52	20,000.00
	34	Haralson	7.40	Topsoil	Sept. 19		30,371.00	15,000.00
	37	De Kalb	5.50	Concrete	Sept. 18		134,778.38	45,591.04
Iowa	13	Webster	12.00	Gravel	Sept. 9		56,466.17	28,233.08
	22	Linn	17.80	Brick, concrete, gravel, and earth	Sept. 28		129,712.00	27,718.86
Kentucky	8	Boyd	5.34	Bituminous macadam	Sept. 9		110,000.00	55,000.00
Maryland	6	Prince George, Howard, and Baltimore	25.00	Concrete	Sept. 19		350,000.00	175,000.00
	7	Baltimore and Hubbard	45.00	do.	do.		370,000.00	185,000.00
Massachusetts	9	Essex	3.122	Bituminous macadam	Sept. 18		125,224.55	31,220.00
Michigan	24	Berrien	7.916	Macadam surface treated	do.		167,375.24	72,090.16
Missouri	4	Boone	2.79	Bituminous macadam	Sept. 9	Sept. 9	32,281.97	16,140.98
	13	Buchanan	2.29	Asphaltic	Sept. 28		42,802.32	21,401.16
Montana	15	Rosebud	4.00	Gravel	Sept. 12		16,414.20	8,207.20
	16	do.	4.00	do.	do.		14,251.38	7,125.69
Nevada	1	Humboldt	16.70	do.	Sept. 24	Sept. 24	77,952.16	38,976.08
	7	Washoe	9.32	Gravel or macadam	Sept. 12	Sept. 12	57,983.20	28,991.60
New Hampshire	19	Cheshire	.60	Gravel	Sept. 9		9,037.08	4,518.54
North Carolina	24	Wake	4.24	Concrete	Sept. 12		68,606.45	25,000.00
	26	Davidson	12.88	Topsoil or sand-clay	Sept. 17		22,517.00	10,000.00
	30	Mecklenberg	6.324	Concrete and bituminous macadam	Sept. 18		102,551.00	26,900.00
North Dakota	4	Richland	20.00	Earth	Sept. 12	Sept. 12	19,198.65	9,599.32
	15	Sargent	31.50	do.	Sept. 9		48,992.79	24,496.39
	30	Divide	9.50	do.	Sept. 12		10,648.00	5,324.00
Ohio	23	Stark	8.09	Brick	do.		390,000.00	80,000.00
Oregon	14	Grant	2.20	Gravel	Sept. 30		51,435.25	22,000.00
South Carolina	18	Greenwood	7.29	Topsoil	Sept. 18		18,649.95	9,324.97
	20	Cherokee	9.26	do.	Sept. 13		39,561.50	16,802.99
South Dakota	8	Butte	11.50	Earth	Sept. 9		20,638.20	10,319.10
Texas	10	Williamson	21.50	Bituminous gravel	Sept. 9	Sept. 9	100,095.17	50,000.00
	25	Dallas	3.00	Macadam with asphalt surface	Sept. 12	Sept. 12	25,155.87	10,000.00
Virginia	10	James City and York	2.462	Concrete	Sept. 18		69,014.44	24,620.00
	14	Augusta	4.012	Waterbound macadam	Sept. 20		49,609.14	24,804.67
	17	Hanover and Caroline		Bridge	Sept. 13		17,392.65	8,696.32
	18	King and Queen, Gloucester, and Middlesex	13.777	Gravel and drained	do.		39,660.81	19,830.40
	19	Fauquier	5.04	Macadam	Sept. 18		57,609.35	28,804.68
Wisconsin	13	Clark	8.81	Graded earth	Sept. 9		20,229.00	6,743.00
Wyoming	12	Lincoln	4.12	Gravel	Sept. 26	Sept. 26	19,982.62	9,991.00
Total			427.939				3,906,672.65	1,383,181.44

1 Conditionally approved July 17.

SEEKS RELIEF FROM ROAD COST.

Mariposa County, Cal., is seeking relief from interest charges on bonds issued for the building of the State highway in that county. Officials of the country say that the State has spent \$340,000 in building a 23-mile road in the county which is traversed mainly by Yosemite tourists, and therefore serves the outside public more than residents. The

interest on the bonds for which the county is charged is \$17,336.56, which means a levy of 50 cents per \$100 valuation, and this, it is maintained, will be an unjust burden. The law provides that interest on State highway bonds must be paid by the county in which the road is built, but a clause permits relief in cases where such taxation is an unreasonable burden to the county.

STATE HIGHWAY MANAGEMENT, CONTROL, AND PROCEDURE

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IN the August and September numbers appeared the chapters on State highway management, control, and procedure. In this number are presented the chapters on two additional States. Each one takes up the development and results of State participation and control of road work and the relation of State to local control: organization, personnel, duties and powers of State and local road officials; classification of State and local roads with particular reference to control and basis of payment, including methods of selection, powers of State highway departments in granting aid, procedure in making surveys, letting contracts, and the control exercised by the State and local officials over road construction and maintenance; sources of State and local funds, basis of allotment and apportionment of State funds, and the relation of State to local funds, and the amount available for road purposes during the latest calendar or fiscal year.

MARYLAND.

Development.—Maryland was among the first States to adopt the principle of State participation in road building. By long-continued and systematic effort and by gradual development there has been constructed a system of about 1,350 miles of first-class trunk-line highways traversing the entire State east and west, north and south. These roads have been constructed and are being maintained at the expense of the State and are entirely under State jurisdiction, both for construction and maintenance. In addition to this, 375 miles of State-aid roads have been constructed at the joint expense of the State and counties. At present these roads are maintained by and at the expense of the State. There are approximately 16,460 miles of public road in Maryland, of which about 2,900 miles, or 17.6 per cent, have been surfaced. Thus about 10.5 per cent of the entire mileage is under State jurisdiction both for construction and maintenance, leaving 7.1 per cent of surfaced roads over which the State has no control.

In 1898 the general assembly authorized the Maryland geological and economic survey to collect and disseminate information on road building, and appropriated \$10,000 per annum for the purpose. This appropriation for educational and propaganda work was continued until 1904, when the State-aid

law was adopted. The geological and economic survey continued to handle the work until 1908, when the State road commission was created and a State road system was provided for. The general assembly of 1908 provided for an issue of \$5,000,000 worth of bonds with which to construct State roads. In 1910 enlarged powers were given to the State roads commission and additional bonds for State roads were provided for.

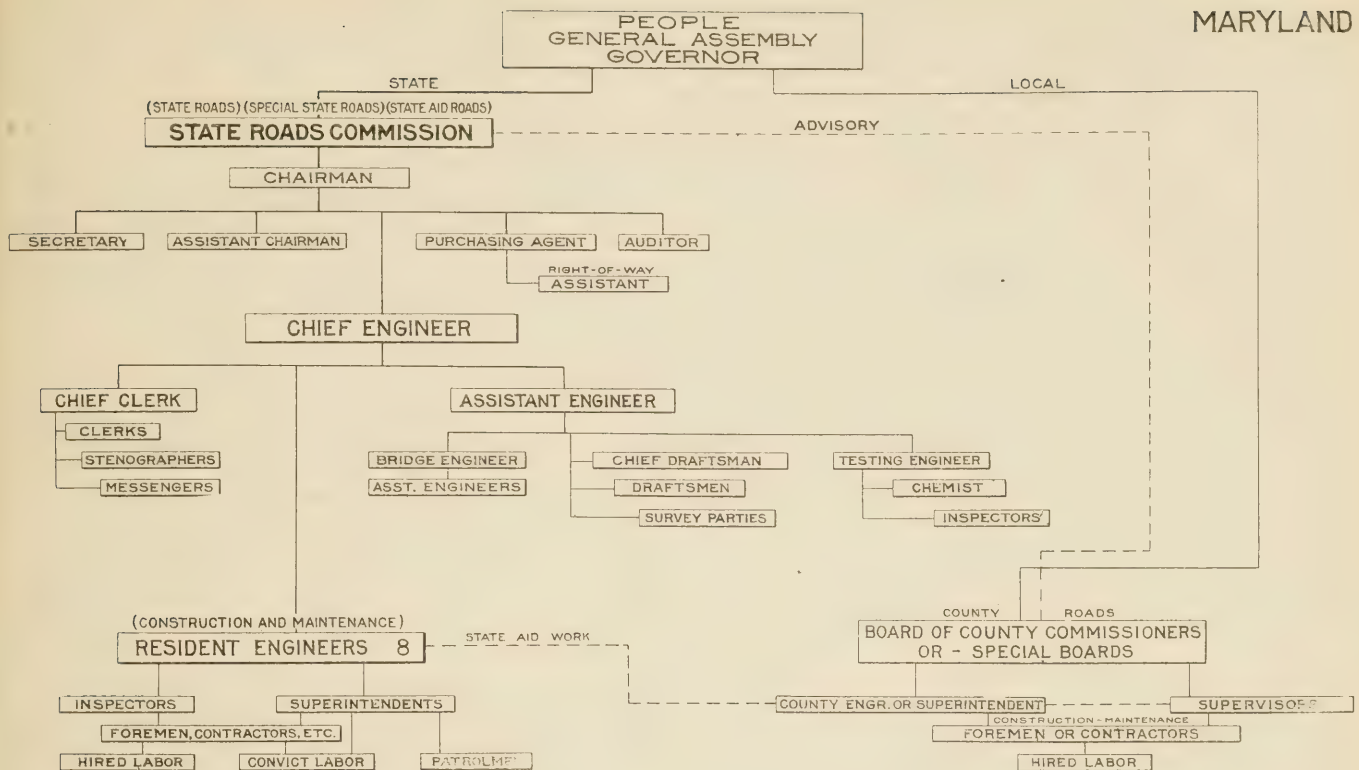
The State funds available for construction and maintenance of State roads and State-aid roads amounted to \$2,138,000 during 1917. The local expenditures not under State control, including county contributions with State aid, amounted to about \$3,300,000, thus showing that the State contributes approximately 39 per cent of all road expenditures. From 1898 to 1917, inclusive, the State expended approximately \$22,000,000 for the construction and maintenance of State and State-aid roads. During 1917 the total expenditure from all sources amounted to \$6,083,682.

ORGANIZATION.

The highway organization of the State and the relation existing between the State and local forces is shown in the diagram given herewith.

State.—At the head of the State highway department is the State roads commission, consisting of three salaried members appointed by the governor and the governor ex-officio. The members may be removed by the governor at any time. They receive a salary of \$2,000 each except the chairman designated by the governor, who receives \$2,500 per annum. The commissioners must be residents of the State and at least one of them must belong and be affiliated with "that one of the two leading political parties of the State opposite to the governor's own political party."

All engineering and technical work of the department is under the chief engineer, who is appointed by the commission and serves during its pleasure. All clerical and technical employees of the department except the secretary are appointed by the commission and serve during the pleasure of the commission under the chief engineer. There is an assistant engineer who has charge of field parties, drafting, testing, and bridge work under the chief engineer. There are also eight division engineers who have charge of construction and maintenance



in the field and to whom all field inspectors having immediate charge of construction and all superintendents having direct charge of maintenance report. The division engineers report to the chief engineer. The clerical work of the department is handled by a chief clerk who reports to the chief engineer. The commission also has a secretary, a purchasing agent, and an auditor, all of whom report directly to the chairman of the commission. The secretary's position is statutory.

Local Organization.—Jurisdiction over all county road and bridge matters is vested in the respective boards of county commissioners, who are elected biennially. The number of commissioners varies in the different counties, being fixed by the code of local laws for each county. In a few of the counties control over road and bridge work is vested in special appointive bodies known as good roads commissions, road boards, road commissioners, etc. All subordinate road officials are appointed by the county commissioners, who are authorized to employ district supervisors in some counties, while in others the work is carried on under the immediate direction of county road engineers or county superintendents. Several counties in the State operate under special laws.

CLASSIFICATION, CONTROL, AND PROCEDURE.

Public roads of Maryland are, for the purpose of fixing responsibility for construction, control, and maintenance, divided into three main groups, namely, State roads, State-aid roads, and county roads.

State Roads.—The State roads commission has absolute control over the construction and maintenance of State roads. At present the system includes 1,300 miles of completed trunk-line roads, and 53 miles of special roads (the Baltimore and

Annapolis and the Baltimore-Washington boulevards).

The State roads are selected by the State roads commission after public hearings and the special roads are designated by the general assembly, but the exact location is fixed by the State roads commission. The State pays the entire cost of construction and maintenance. The patrol and gang systems of maintenance are extensively used in the maintenance of State roads. State convicts may be used by the State roads commission for construction and maintenance, and if so used the State pays from State funds for the maintenance of such convicts.

State-Aid Roads.—These are constructed at the joint expense of the State and counties and under the general supervision of the State roads commission. On January 1, 1918, about 375 miles of State-aid roads had been completed. Petitions for State aid originate with county commissioners or with two-thirds of the property owners abutting on the road, who agree to pay 10 per cent of the cost. County commissioners forward petitions to the State roads commission, who may grant aid or reject petition. Surveys, plans, specifications, and estimates are made by the State roads department, but the county is required to pay \$50 per mile for making surveys. After plans, specifications, and estimates are approved by the State roads commission and the county commissioners the latter advertise for bids and let the contract subject to the approval of the State roads commission. The work then proceeds under the direction of a resident engineer of the State highway department, the expense of supervision being apportioned to the various State-aid projects. Payments for construction are made on monthly estimates, 50 per cent by the State and 50 per cent by the counties. Of the counties' share, 10 per cent is charged to abutting property owners.

State convicts may be used by the State roads commission, and, if so used, the State-aid money apportioned to any county may be used by the county commissioners to pay for the maintenance of such convicts.

Previous to 1916 State-aid roads were maintained by and at the expense of the counties under State supervision, but the law of 1916 provided that such roads should be maintained by and at the expense of the State in the same manner as State roads. All State-aid roads constructed previous to 1916, which were first put in good condition by the counties, were taken over by the State. The State roads commission allows \$250 per mile for maintenance on all such roads which have not been so taken over.

County Roads are those constructed and maintained by the county with county funds and include all roads in the State except those above indicated. There are about 14,735 miles of county roads in the State, of which about 1,175 miles had been surfaced up to January 1, 1917. County roads are built by contract, day labor, or with county or State prisoners. If State convicts are used, the county benefited pays for their maintenance.

REVENUES.

State.—Funds for the construction of State roads and special State roads are derived from State bond issues. Funds for the construction of State-aid roads are derived from State appropriations, while funds for the maintenance of State and State-aid roads are derived from net automobile fees funds collected by the State automobile commissioner. Four-fifths of the automobile fees funds are used for State purposes and one-fifth is apportioned to Baltimore City for the maintenance of roads and streets in the city. Funds used for administration and engineering are taken as needed by the State roads commission from the various appropriations and funds available. The State road funds are expended at the discretion of the State roads commission, except on special roads for which specific sums are set aside by the general assembly. State-aid appropriations are apportioned to the various counties on a mileage basis, while the motor vehicle funds are apportioned by the commission to the various counties as needed. From 1908 to 1916 \$200,000 annually was appropriated by the general assembly for State-aid roads. Since 1916 the annual appropriation has amounted to \$300,000. Thus, the State has appropriated and applied to construction of State-aid roads from 1908 to 1917, inclusive, approximately \$2,300,000.

The State funds available for all State and State-aid purposes during the fiscal year 1917 were as follows:

Construction of State roads, fiscal year ending September 30, 1917.....	\$1,200,000
Construction of State-aid roads, fiscal year ending September 30, 1917.....	300,000
For maintenance of State and State-aid and special roads from automobile fees fund, May 1, 1917 to April 30, 1918.....	638,000
Total State funds.....	\$2,138,000

Local.—Funds for the construction of county roads are derived from regular and special levies fixed by the boards of county commissioners, and from county bond issues authorized by the general

assembly. The sums raised, including county contributions, to meet State-aid amounts to approximately \$3,300,000 annually.

BONDS.

State.—The State constitution provides that no public debt may be contracted by the general assembly unless an annual tax is provided which will be sufficient to pay interest and retire the debt as it falls due, and that the principal of such debts shall be paid within 15 years. The terms of State bonds are, therefore, limited to 15 years and the law authorizing the debts fixes a State tax sufficient to pay interest and principal. The total amount of State road bonds authorized by the five general assemblies 1908, 1910, 1912, 1914, and 1916 was \$18,930,000, and are given in detail as follows:

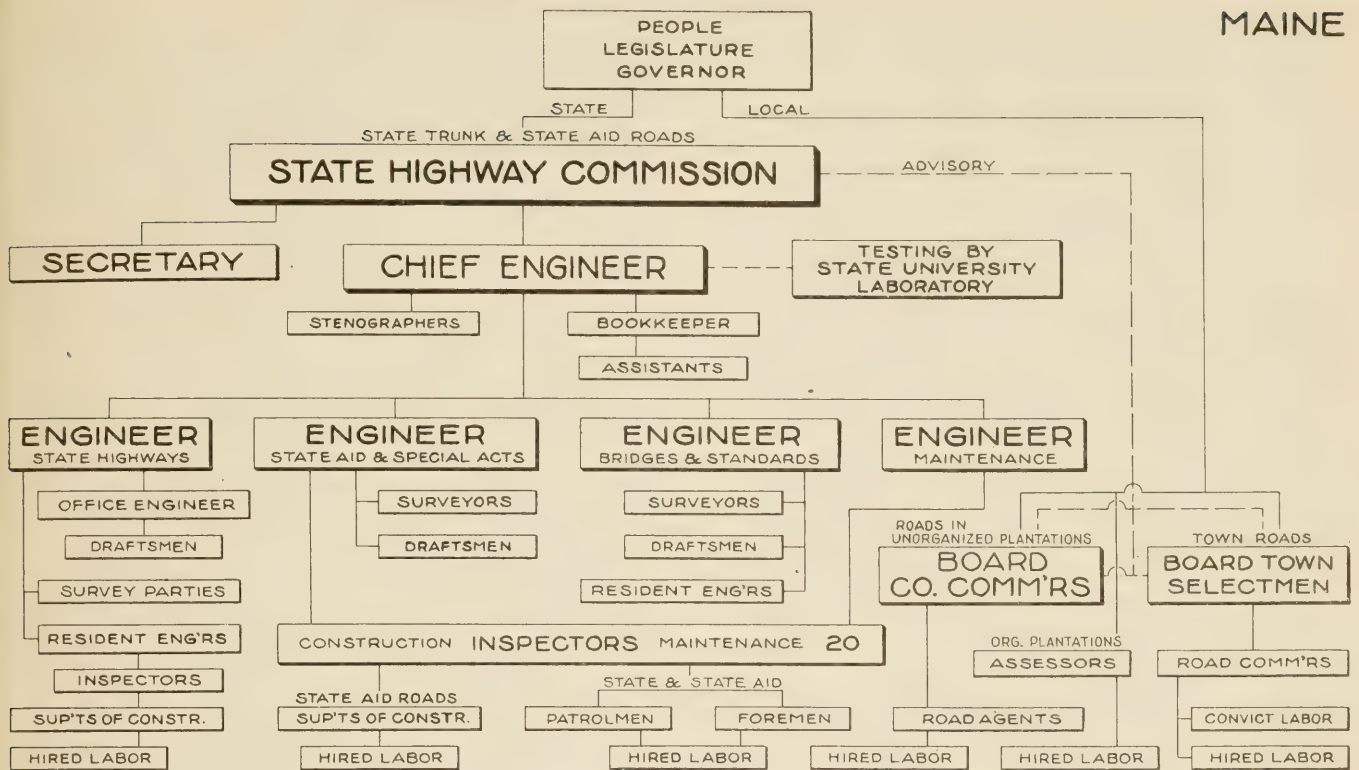
Year authorized.	Amount authorized.	Interest rate.	Net proceeds.
		<i>Per cent.</i>	
1908.....	\$5,000,000	3½	\$4,760,209.76
1910.....	1,000,000	4	991,447.55
1912.....	3,170,000	4	3,110,432.61
1914.....	6,600,000	4	6,514,434.15
1916.....	2,160,000	4	

The State tax authorized to be levied by the various county commissioners and the mayor and city council of Baltimore for the purpose of paying the interest and principal is shown as follows:

Amount authorized.	Tax rates, in cents, per \$100 of assessable property, for years succeeding sale of bonds.					
	First year.	Second year.	Third year.	Fourth year.	Fifth year.	Annually thereafter to fifteenth year.
\$5,000,000.....	2	3½	4½	5½	6	6
\$1,000,000.....	¼	½	¾	1	1	1
\$3,170,000.....	3	3	3	3	3	3
\$6,600,000.....	2½	2½	6	6	6	6
\$2,160,000.....	1½	2	2¾	2¾	2¾	2¾

The first, second, and third issues were of the sinking-fund variety, but were issued subject to call after 10 years. The last two issues were of the deferred serial annuity type—that is, the first payment was to be made three years from the date of issue, and the other payments were to be made in such a manner that the average annual outlay for interest and principal would be to some extent equalized. Thus, the early payments for interest are relatively large and the amounts paid for principal are relatively small, and vice versa for the series maturing later. Maryland is the first State to adopt the annuity principle of bond retirement.

Local.—Special enabling acts are passed from time to time authorizing county bond issues. There appears to be very little similarity in these acts and no fixed policy governing the issuance of local bonds. In some cases the county commissioners are authorized and directed to issue the bonds, while in others a majority vote of the people is required before the bonds can be issued. Sinking-fund bonds have been authorized in some cases, while serial bonds have been provided for in others. The terms and interest rates also vary.



MAINE.

Development.—State support and participation in road improvement in Maine is of State-wide extent, is conducted on a fairly extensive scale, and is administered by the State highway commission. The principle of State aid had its beginning in 1901 and from that date State support in the form of money aid has been made a permanent policy.

Maine was the first State to make use of auto-license revenues as a fund to pay interest and principal of State bonds issued for road improvement purposes.

A trunk-line system comprising 5½ per cent of the total road mileage of the State and which connects all counties of the State has been designated by and is being improved by or under supervision of the State highway commission. It is reported that this system of roads when completed will serve 74 per cent of the population and 73 per cent of the assessed valuation of the State.

At present about 3,250 miles, or 14 per cent, of the total road mileage of the State has been hard surfaced, the cost having been borne by all road forces of the State, namely, State, county, and towns.

In 1916 a total of \$3,167,215 was expended by all road forces of the State. Of this amount, \$1,055,250 of State funds and \$453,518 of local funds were expended by or under the supervision of the State highway commission. Thus the State supervised the expenditure of 47.5 per cent of the total and contributed about 33 per cent of all expenditures. During 1917 the total expenditures from all sources amounted to \$3,244,982.

ORGANIZATION.

The organization of the road forces of the State and the relation existing between them is shown herewith.

State.—At the head of the road forces of the State is the State highway commission composed of three members appointed by the governor for terms of three years. The commission selects, with the approval of the governor and council, the chief engineer, who serves at their pleasure, and who acts as the executive official of the commission.

The commission has power and is required to select systems of State and State-aid highways; to issue and enforce rules and regulations relative to construction and maintenance of such highways; to direct the expenditure of all State funds provided for road purposes; to enter into such contracts as may be necessary to carry out the provisions of the laws of the State pertaining to State and State-aid highways; and to advise local officials on such road and bridge matters as may be brought to their attention.

The chief engineer, with the approval of the commission, has the right to employ at a compensation fixed by them such force of assistants and clerks as may be required.

County.—Authority over road affairs in counties is vested in a board of three commissioners elected for terms of six years, one being elected biennially. The board has the power upon petition to lay out, alter, or discontinue highways and to expend funds thereon for their improvement. In unincorporated townships—i. e., “wild land” townships in which there are practically no settlers—the board has full

control over all road matters not otherwise delegated to the State, and has the power to appoint suitable agents to superintend the construction and repair of roads.

Town.—Authority over town road affairs is vested in a board of selectmen consisting of three, five, or seven elective members. The board so constituted has the power to levy taxes voted by the towns at their annual meetings for road or highway purposes, and to employ proper persons to carry out the work. The board may exercise the right of eminent domain over lands containing road building materials suitable for highway purposes, and may enter into contracts or agreements with the State highway commission, when so authorized by vote of the town, relative to improvement of the roads under their control.

CLASSIFICATION, CONTROL, AND PROCEDURE.

The 23,537 miles of public road in Maine are divided for the purpose of fixing responsibility for control, construction, and maintenance into three grades, viz, State highways, State-aid highways, and county or town highways.

State Highways.—These comprise about 1,300 miles of road designated by the State highway commission of which 550 miles were improved or contracted for on January 1, 1918. Such roads have been or are to be constructed by the State highway commission with State funds. They are maintained by the State highway commission, the town in which any State highway is located contributing \$60 per mile per annum toward the maintenance expense.

State-Aid Highways.—Sections of State highways or roads of local importance improved with State and local funds under supervision of the State highway commission are called State-aid highways. The roads comprising this system are designated on the initiative of town or county boards by a joint agreement between the board and the State highway commission. Maintenance is executed by the State highway commission with State funds, the local board contributing not to exceed \$30 per mile per annum. Of the State-aid system 1,560 miles were completed or under contract on January 1, 1918.

State aid is allotted according to a scale provided by the State law and only when the town agrees to provide an amount required of them. The allotment law in general provides that the State will furnish aid ranging from an amount equal to the local contribution to an amount equal to two and two-thirds times the local appropriation. The ratio and the amount of local contributions are dependent on and vary inversely with the assessed valuation of the town. Under certain circumstances the amount of local contributions may be increased up to fivefold, in which event the State similarly increases its regular pro rata contribution and gives a bonus of 25 per cent of the extra aid.

County or town roads comprise all other roads of the State. They are improved and maintained by the town in which they are located.

Bridges on State highways or other improved highways when so decided by a joint board composed of the State highway commission, the county commissioners, and the municipal officers of the city or town in which the bridge is located, are built by the State, the costs being apportioned 50 per cent to the

town, 30 per cent to the county, and 20 per cent to the State.

State highways, State-aid highways, and such local work as may be delegated to the State highway commission may be executed by force account or by contract. Such contracts may be let with or without advertising when deemed by the commission of advantage to the public interest to do so. Convict or prison labor may be employed on highway work, but it has been used only in two or three instances.

Surveys, plans, and specifications for all work involving the use of State or Federal funds are executed by the State highway commission. When let by contract each bid must be accompanied by a certified check payable to the treasurer of the State in an amount equal to 10 per cent of the bid. Towns may bid on and receive contracts through proper officials, and when they secure contracts they are not required to provide bond. Otherwise the successful contractor files a bond in an amount specified by the State highway commission.

During construction, the work is under the inspection and supervision of a resident engineer assigned by the chief engineer. Monthly payments to the contractor are based on estimates prepared by the resident engineer and approved by the chief engineer.

Final payments are made in a similar manner when the road has been completed and accepted by the chief engineer or his authorized representative.

REVENUES.

State.—State revenues for 1917 were provided by (1) direct appropriation of \$300,000 by the legislature for State-aid highways, and \$100,000 for bridges; (2) \$300,000 from the proceeds of a \$2,000,000 bond issue, which funds are available for State highways; (3) appropriation as aid to poor towns, \$145,000; (4) receipts from the imposition of a license on motor vehicles and the operators thereof. These last funds are: (a) To pay interest on the bonds issued, (b) to pay principal of bond issue, (c) to support State highway department, (d) to maintain State and State-aid highways. There was transferred from this fund, by order of the governor and council, \$162,876.58 for State highway construction in 1917.

Effective in 1918 a State-wide tax of 1 mill on each dollar of assessed valuation will be levied on all taxable property in the State, the proceeds of this tax being available for State and State-aid highways. It is expected that this tax will yield \$521,000.

County and Town.—Funds for road improvement are raised by taxes on real and personal property at rates fixed by the board of selectmen and by a poll tax levied on male inhabitants not exempt by law.

Bonds may be issued by towns in an amount equal to 5 per cent of the total assessed valuation of the town.

State bonds of the serial type payable within 41 years from the date of issue and bearing not to exceed 4 per cent interest may be issued in amount not to exceed \$500,000 a year or a total of \$2,000,000 outstanding at any one time. The interest and principal of such bonds are paid from State motor vehicle fees. The total State bonds outstanding at present amount to \$1,800,000.

ROAD PUBLICATIONS OF BUREAU OF PUBLIC ROADS.

NOTE.—Application for the free publications in this list should be made to the Chief of the Division of Publications, U. S. Department of Agriculture, Washington, D. C. Applicants are urged to ask only for those publications in which they are particularly interested. The Department can not undertake to supply complete sets, nor to send free more than one copy of any publication to any one person. The editions of some of the publications are necessarily limited, and when the Department's free supply is exhausted and no funds are available for procuring additional copies, applicants are referred to the Superintendent of Documents, Government Printing Office, this city, who has them for sale at a nominal price, under the law of January 12, 1895. Those publications in this list, the Department supply of which is exhausted, can only be secured by purchase from the Superintendent of Documents, who is not authorized to furnish publications free. In applying for these publications the name of the series as well as the number of the publication should be given, as "Bureau of Public Roads Bulletin No. 32."

REPORTS

Report of the Director of the Office of Public Roads for 1916.
Report of the Director of the Office of Public Roads for 1917.

OFFICE OF PUBLIC ROADS BULLETINS.

- *Bul. 28. The Decomposition of the Feldspars (1907). 10c.
- 32. Public Road Mileage Revenues and Expenditures in the United States in 1904. 15c.
- *37. Examination and classification of Rocks for Road Building, including Physical Properties of Rocks with Reference to Their Mineral Composition and Structure. (1911.) 15c.
- *43. Highway Bridges and Culverts. (1912.) 15c.
- *45. Data for Use in Designing Culverts and Short-span Bridges. (1913.) 15c.
- 48. Repair and Maintenance of Highways (1913).

DEPARTMENT BULLETINS.

- Dept. Bul. *53. Object-Lesson and Experimental Roads and Bridge Construction of the U. S. Office of Public Roads, 1912-13. 5c.
- 105. Progress Report of Experiments in Dust Prevention and Road Preservation, 1913
- 136. Highway Bonds.
- 220. Descriptive Catalogue of Road Models of Office of Public Roads.
- 230. Oil Mixed Portland Cement Concrete.
- 249. Portland Cement Concrete Pavements for Country Roads.
- 257. Progress Report of Experiments in Dust Prevention and Road Preservation, 1914.
- *284. Construction and Maintenance of Roads and Bridges, from July 1, 1913, to December 31, 1914. 10c.
- 314. Methods for the Examination of Bituminous Road Materials.
- 347. Methods for the Determination of the Physical Properties of Road-Building Rock.
- *348. Relation of Mineral Composition and Rock Structure to the Physical Properties of Road Materials. 10c.
- 370. The Results of physical Tests of Road-Building Rock.
- 373. Brick Roads.
- 386. Public Road Mileage and Revenues in the Middle Atlantic States.
- 387. Public Road Mileage and Revenues in the Southern States.
- 388. Public Road Mileage and Revenues in the New England States.
- 389. Public Road Mileage and Revenues in the Central, Mountain, and Pacific States, 1914.
- 390. Public Road Mileage in the United States. A summary.
- 393. Economic Surveys of County Highway Improvement.
- 407. Progress Reports of Experiments in Dust Prevention and Road Preservation, 1915.
- 414. Convict Labor for Road Work.
- 463. Earth, Sand-Clay, and Gravel Roads.
- 532. The Expansion and Contraction of Concrete and Concrete Roads.
- 537. The Results of Physical Tests of Road-Building Rock in 1916, including all Compression Tests.
- 555. Standard Forms for Specifications, Tests, Reports, and Methods of Sampling for Road Materials
- 583. Report on Experimental Convict Road Camp, Fulton County, Ga
- 586. Progress Reports of Experiments in Dust Prevention and Road Preservation, 1916.
- 660. Highway Cost Keeping.

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- 670. The Results of Physical Tests of Road-Building Rock in 1916 and 1917.
- 691. Typical Specifications for Bituminous Road Materials.
- 704. Typical Specifications for Nonbituminous Road Materials.
- 724. Drainage Methods and Foundations for County Roads.

OFFICE OF PUBLIC ROADS CIRCULARS.

- Cir. 89. Progress Report of Experiments with Dust Preventatives, 1907.
- *90. Progress Report of Experiments in Dust Prevention, Road Preservation, and Road Construction, 1908. 5c.
- *92. Progress Report of Experiments in Dust Prevention and Road Preservation, 1909. 5c.
- *94. Progress Reports of Experiments in Dust Prevention and Road Preservation, 1910. 5c.
- 98. Progress Reports of Experiments in Dust Prevention and Road Preservation, 1911.
- *99. Progress Reports of Experiments in Dust Prevention and Road Preservation, 1912. 5c.
- *100. Typical Specifications for Fabrication and Erection of Steel Highway Bridges. (1913.) 5c.

OFFICE OF THE SECRETARY CIRCULARS.

- Sec. Cir. *49. Motor Vehicle Registrations and Revenues, 1914. 5c.
- 52. State Highway Mileage and Expenditures to January 1, 1915.
- 59. Automobile Registrations, Licenses, and Revenues in the United States, 1915.
- 62. Factors of Apportionment to States under Federal Aid Road Act Appropriation for the Fiscal Year 1917.
- 63. State Highway Mileage and Expenditures to January 1, 1916.
- 65. Rules and Regulations of the Secretary of Agriculture for Carrying out the Federal Aid Road Act.
- 72. Width of Wagon Tires Recommended for Loads of Varying Magnitude on Earth and Gravel Roads.
- 73. Automobile Registrations, Licenses, and Revenues in the United States, 1916.
- 74. State Highway Mileage and Expenditures for the Calendar Year 1916.
- 77. Experimental Roads in the Vicinity of Washington, D. C.

FARMERS' BULLETIN.

- F. B. 338. Macadam Roads.
- 505. Benefits of Improved Roads.
- 597. The Road Drag.

YEARBOOK SEPARATES.

- Y. B. Sep. *638. State Management of Public Roads; Its Development and Trend. 5c.
- *712. Sewage Disposal on the Farm. 5c.
- 727. Design of Public Roads.
- 739. Federal Aid to Highways.

REPRINTS FROM THE JOURNAL OF AGRICULTURAL RESEARCH.

- Vol. 5, No. 17, D-2. Effect of Controllable Variables Upon the Penetration Test for Asphalts and Asphalt Cements.
- Vol. 5, No. 19, D-3. Relation Between Properties of Hardness and Toughness of Road-Building Rock.
- Vol. 5, No. 20, D-4. Apparatus for Measuring the Wear of Concrete Roads.
- Vol. 5, No. 24, D-6. A New Penetration Needle for Use in Testing Bituminous Materials.
- Vol. 6, No. 6, D-8. Tests of Three Large-Sized Reinforced-Concrete Slabs under Concentrated Loading.
- *Vol. 10, No. 5, D-12. Influence of Grading on the Value of Fine Aggregate Used in Portland Cement Concrete Road Construction. 15c.
- Vol. 10, No. 7, D-13. Toughness of Bituminous Aggregates.
- Vol. 11, No. 10, D-15. Tests of a Large-Sized Reinforced-Concrete Slab Subjected to Eccentric Concentrated Loads.

*Department supply exhausted.

Resumption and Extension of Highway Construction

WE must resume as quickly as possible, in full measure, the operations under the Federal Aid Road Act. You understand why they had to be contracted during the war. It is highly important that they be resumed. I need not emphasize before you the fact that good roads are prerequisite for better agriculture, for orderly distribution, and for a healthful and attractive country life. From unexpended balances of Federal appropriations for the last few years, from State funds beyond what was necessary to meet the Federal allotments, and from amounts available during the current fiscal year, we shall have for expenditure during the calendar year approximately \$75,000,000. Next year, if all the balances should be expended during this year and we should have to rely solely on the funds accruing next year, we shall have from Federal appropriations about \$20,000,000 and probably more than this amount from State sources. The States, in addition, will expend sums in excess of what they have assigned, or will assign, for Federal aid road projects. Still, it seems to me that we should take a further step—take this step not only because of the importance of good roads, but also because of the desirability of furnishing worthy projects on which unemployed labor during the period of readjustment may be engaged. There will be many things suggested for which Federal and State funds will be sought. Some of these will be unworthy. Clearly such public works as roads are worthy, and it would be in the public interest to make available larger appropriations from the Federal Treasury, to be used separately or in conjunction with State and local support.

There need be no delay in the execution of such a program. The Nation has already provided the machinery in the Department of Agriculture and in the State highway commissions. The Federal Aid Road Act was fruitful of good legislation and each State in the Union now has a central highway authority with power and funds to meet the terms of the Federal Act. The two agencies, in conjunction, have been engaged in devising well-considered road systems and in making surveys, plans, and specifications. The task will be one of selection and those roads should be designated for improvement which are of the greatest economic importance, with due regard to such military and other needs as are proper for consideration. There is no necessity for any departure from this scheme. The suggestions made have been canvassed with the President, the Secretary of War, and the Postmaster General, and they are in accord with the view that additional funds should be made available to this department and that they should be expended through existing machinery.

From an address by Secretary Houston.

